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GENERAL AMERICAN TRANSPORTATION CORPORATION

SHELTER LIGHTING KIT

by

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OCD Work Unit 1427A

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REVIEW NOTICE

This report has been reviewed in the Office of Civil Defense and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Office of Civil Defense.

FOREWORD

The General American Research Division (GARD) of General American Transportation Corporation was contracted by Stanford Research Institute (SRI) for the Office of Civil Defense to design a prototype Lighting Kit for use in fallout shelters. This program was performed under SRI Subcontract B-87001(4949A-62)-US, OCD Work Unit 1427A, with Mr. James F. Halsey of SRI serving as project monitor.

ABSTRACT

The Shelter Lighting Kit includes a manually-driven power unit and a fluorescent lighting system. Two power unit designs are presented for preproduction fabrication and evaluation. One power unit has a generator mounted on a bicycle-type frame and driven by a chain and sprocket transmission; while the other unit has a generator with an integral geared transmission mounted on a folding tripod frame. Both power units are designed for one-man operation with a power input of 0.1 horsepower at a nominal pedal speed of 55 rpm and a nominal generator output of 50 watts at 120 volts AC. The selection of either design for the production model will depend on their performance and a cost analysis. The fluorescent lighting system consists of two adjustable lamp fixtures and two 20-watt or 25-watt preheat fluorescent lamps operated in series (selected lamp wattage will depend on the overall system efficiency). The estimated production cost of the lighting kit is $90.

An incandescent lighting system is proposed as an optional accessory for night lighting or background illumination in multi-room shelters. This lighting system consists of five 10-watt incandescent lamps with adapter sockets and five 50-foot extension cords. The estimated cost of this accessory is $7.30.

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SECTION 1

INTRODUCTION

According to the Second National Fallout Shelter Survey there are 226,000 basement and special facilities (such as mines, caves, etc.) which can accommodate 55.8 million people. These facilities generally have no natural illumination and therefore require a means of artificial lighting. Approximately one-quarter to one foot candles of illumination are needed in these shelters to maintain the minimum survival requirements (Ref. 1). In addition to this background illumination, higher levels are required in the administrative, medical, and kitchen areas.

The emergency lighting systems considered to date for these shelters are:

1) a 100-watt "Light Admitting Device" which uses the sun as a light source and a mirror system for distribution (Ref. 2),

2) a 550-watt "Self-Contained Generator" which produces electrical power and provides oxygen and water through the decomposition of 90 percent hydrogen peroxide (Ref. 3),

3) a series of 0.5 to 5 KVA generators driven by four-cycle engines using liquified-petroleum gases (propane and butane) as the fuel (Ref. 4), and

4) an automotive generator driven either manually or by a gasoline engine (Ref. 5).

These systems are either expensive, require periodic maintenance, or are difficult to operate manually. Item 4 above consisted of both an automotive alternator and an automotive generator driven independently through a 24-inch bicycle. In this case, two methods of coupling were attempted: direct friction drive, which proved too difficult to operate, and belt drive. Pedaling the alternator at 60 rpm through a belt drive transmission resulted in 36 watts of power and could be sustained for a maximum of five minutes. It was also found that charging of a storage battery with this system was not practical. The maximum charge obtained was 2 amps for one minute with physical endurance being the limiting factor. These alternators and generators are specifically designed for larger loads and high speeds with power inputs of up to 4 horsepower. Since these generators are not designed for manual operation, the Office of Civil Defense initiated this program to study the design and development possibilities of an inexpensive lighting kit consisting of a fluorescent or incandescent lighting system and a power unit which can be manually driven by one person for extended periods of time. The primary function of the lighting kit is to furnish illumination with emphasis on maximum efficiency and performance at minimum costs. A secondary function of the power unit could be to furnish a means of recharging dry cell batteries, which are used in Civil Defense radiological equipment, or operating radio receivers in the shelters.

SECTION 2

DESIGN CRITERIA AND EVALUATION

The basic considerations in designing a shelter lighting kit are human factors, types of lighting, and methods of generating electrical power. An extensive amount of data concerning human factors (such as pedal speeds, optimum and maximum power inputs, and work/rest cycles) has been established in the development of the shelter Ventilation Kit as described in Specification MIL-V-40645 (Ref. 6); however, little data has been documented on the optimum types of lighting and the methods of electrical power generation for this application. This section analyzes types of lighting systems and generators for use in a shelter lighting kit, and evaluates them by means of an experimental unit. Section 3 presents the design of a matched lighting and generator system.

2.1 Lighting

The two types of artificial illumination suitable for a shelter application are fluorescent and incandescent lighting. The type selected depends on its application (high intensity or background illumination), the lumen output, the total cost of the lighting system, and the performance characteristics of the power source.

2.1.1 Fluorescent

The fluorescent lamp is an electric discharge lamp usually in the form of a long tube coated internally with one or more fluorescent powders commonly called phosphors. Cathodes are located at each end of the tube. The lamp is filled to a low pressure with a noble gas to which usually is added a small drop of mercury. The discharge passing through this gas and mercury vapor generates ultraviolet radiation which in turn excites the phosphor to emit light.

Since fluorescent lamps have a negative resistance characteristic, they must be operated in circuits which include current control, such as a ballast, in series with the lamp. A number of different means of lamp starting have been developed since the advent of the fluorescent lamp (Ref. 7). The first is preheat-starting using low voltage but requiring an automatic or manual starting switch. In this method of starting, a circuit which connects both cathodes of the lamp in series with the power source is closed by an automatic or manual switch. The cathodes are momentarily heated (approximately 1 second) and the immediate surrounding gas is ionized. The cathode circuit is then opened by the switch, causing a transient voltage to be built up in the ballast. This voltage is sufficient to strike the arc between the cathodes and start the lamp. Once the lamp starts, the ballast acts as a current limiting device, since there is essentially a short circuit across the lamp. The second method is instant-starting, which requires a higher voltage, but no cathode heating. The ballast, functioning as a transformer, impresses a high voltage (400 to 1000 volts) across the cathodes of the lamp to strike the arc. The most recent method is rapid-starting, where the use of continuously heated cathodes has resulted in lamp starting without high voltage or starting switches.

Fluorescent lamps designed for preheat and rapid starting are the most commonly used lamps in sizes 40-watt and less. Instant-start lamps are generally used in larger sizes and require more input power. Table I shows costs and performance data for typical and commercially available preheat and rapid-start fluorescent lamps.

TABLE I

PERFORMANCE OF FLUORESCENT LAMPS

TYPE OF LAMP	PREHEAT										RAPID START
Nominal Rating, Watts	4	6	8	13	14	15	20	25	30	40	30
Actual Power Input, Watts	3.7	5.8	7.9	13.0	13.4	15.0	19.6	26.0	30.4	40.0	30.0
Lamp Operating Volts	32	45	56	96	37	55	55	60	98	101	75
Light Output, Lumens (see Note 2)	113	250	400	735	720	850	1250	1815	2180	3250	2400
Ballast Power Loss, Watts	2	2	2	6	6	5	6	6	11	11	14-20
Lamp Cost, dollars	0.80	0.80	0.80	0.92	0.56	0.56	0.51	1.08	0.66	0.58	0.80
Starter Cost, dollars	0.22	0.22	0.22	0.12	0.12	0.12	0.12	0.20	0.12	0.12	0.00
Ballast Cost, dollars	0.42	0.42	0.42	1.77	3.47	3.47	3.47	0.64 (3)	3.47	3.47	3.87
Lumens Per Lamp Watt	30	43	50	56	53	56	64	70	71	81	80
Lumens Per Lamp-Starter Dollar	111	245	392	706	1075	1250	1985	1445	2880	4640	3000
Lumens Per Lamp-Starter-Ballast Dollar	78	173	278	262	173	205	305	946	513	780	515

NOTES:
(1) Based on quantity of 100,000 units (Ref. 8).
(2) White and warm white lamps.
(3) Ballast with low power factor.

2.1.2 Incandescent

Incandescent lamps are available in a variety of bulb shapes, sizes, bases, filaments, and colors (Ref. 9). Each lamp is designed for a particular application, such as general illumination, infrared heating, floodlighting, and spotlighting. Lamp operating voltages range from 6 volts to 260 volts, alternating current or direct current, and the lamps are rated from 3 watts to 1,500 watts. Table II presents the performance data and costs for typical incandescent lamps with medium bases (screw-type, 120 volt).

Table II

PERFORMANCE OF INCANDESCENT LAMPS

Nominal Lamp Watts	7.5	10	15	25	40	50
Lamp Operating Volts	115-125	115-125	120	120	120	120
Light Output, Lumens	53	79	144	262	470	685
Lamp Cost, Dollars	0.11	0.11	0.11	0.12	0.12	0.12
Lumens Per Lamp Watt	7.1	7.9	9.6	10.5	11.7	13.7
Lumens Per Lamp Dollar	482	718	1310	2180	3920	5700

NOTES: 1) Based on General Electric Company data (Ref. 10).
2) Based on quantity of 100,000 units (Ref. 11)

2.1.3 Lighting Analysis

The significant advantage of fluorescent lighting is that it produces a lumen output approximately six times that of incandescent lighting for the same power input (see Tables I and II); however, using fluorescent lights in a shelter lighting kit has a few disadvantages, such as its greater cost, the power losses in the accessories, and the length of the lamps. The cost of the ballast and starter required in the standard fluorescent lighting circuit can be as much as seven times the cost of the lamp. For example, a 20-watt fluorescent lamp costs $0.51, while the ballast costs $3.47. The power consumed by the ballast is high and can be as much as one-third that consumed by the lamp. A 20-watt fluorescent lamp has an additional 6-watt loss in the ballast. Fluorescent lamps can present a safety hazard if the tubes are broken because they contain mercury vapor. This gas is noxious and if allowed to escape from a broken lamp could present a health hazard in a small closed room. Generally, shelters are large and are ventilated sufficiently so that this problem is not significant.

The advantages of incandescent lighting are its greater simplicity, lower cost, and compactness. Although the light output of an incandescent lamp is approximately one-sixth that of a fluorescent lamp, the cost of an incandescent lamp is approximately one-thirtieth. For example, the cost of a 40-watt fluorescent lamp with accessories (excluding the fixture) is $4.17, whereas, the cost of a 40-watt incandescent lamp is only $0.12. This large cost difference is primarily due to the cost of the ballast in the standard fluorescent lighting circuit. When comparing the light output of fluorescent and incandescent lamps on a cost basis, it can be seen that a standard fluorescent light circuit is extremely expensive (see Tables I and II). If the ballast could be deleted for a shelter lighting system, this method of illumination would be more economical. For example, the comparison of a 40-watt system is shown in Table III.

TABLE III

COMPARISON OF 40-WATT FLUORESCENT AND INCANDESCENT LIGHTING SYSTEMS

SYSTEM*	COST	LUMENS PER DOLLAR
Standard circuit with Lamp, Starter, and Ballast	$ 4.17	780
Special circuit with Lamp and Starter. No Ballast.	0.70	4640
Incandescent Lamp.	0.12	3920

*Fixture costs are not included.

It is possible to eliminate the ballast in a fluorescent lamp circuit (see Section 2.3.2) by selecting a generator which has an impedance that is matched to the characteristics of the lamp. If preheat fluorescent lamps are used, the windings of the generator can produce the transient voltage or inductive "kick" required to strike the arc when the switch in the cathode circuit is opened. The impedance of the windings will limit the current once the lamp has started. With this arrangement, the lamp ballast is essentially built into the generator and the high cost and power losses normally associated with a standard ballast are eliminated. Fluorescent lighting using the generator to provide the ballast for the lamp is ideally suited for the shelter lighting kit.

The selection of the optimum number and size of lamps to be included in a lighting kit depends on the efficiency of the power unit and the available input horsepower. Table IV shows the estimated power for a nominal 0.1

horsepower unit using incandescent and fluorescent lamps. The 40-watt fluorescent lamp has the highest lumen per watt rating (81 lumens per watt) of all the individual lamps (see Table I); however, a lighting system using a single lamp has an undesirable effect of concentrating all the light in one location. Two 20 or 25-watt fluorescent lamps can be placed in series to provide a more even distribution of light over a larger area and in more than one room. In addition, these lamps can be readily packaged within the kit, while the 40-watt lamp (48 inches long) would require an unreasonable packaging problem. Two 25-watt lamps in series can be used with power units that have gear transmissions with mechanical efficiencies of 90 percent or higher. Two 20-watt lamps in series would be used with power units having lower efficiencies (see Section 2.2.3). Of primary importance is the reduced light output when using either five 10-watt or one 40-watt incandescent lamp. Any of these arrangements will result in a power input to the system less than 0.127 horsepower.

TABLE IV

POWER REQUIREMENTS FOR FLUORESCENT LIGHTING

LAMPS				Length (inches)	Operating Volts	Light Output (lumens)	Generator Input Watts[1]	Manual Horsepower Input	
	NO.	WATTS Nominal	WATTS Actual					Chain Drive[2] 80% Efficiency	Gear Drive[3] 90% Efficiency
Fluorescent	2	15	30.0	18	110	1700	44.1	0.074	0.066
Fluorescent	2	20	39.2	24	110	2500	56.2	0.094	0.084
Fluorescent	2	25	52.0	33	120	3630	75.5	0.127	0.113
Fluorescent	1	40	40.0	48	101	3250	57.3	0.096	0.085
Incandescent	5	10	50.0	---	115-125	395	72.2	0.121	0.107
Incandescent	1	40	40.0	---	120	470	57.3	0.096	0.085

NOTES:
1. Generator efficiency based on performance data as shown in Figure 2.
2. See Section 2.2.3 for the estimated efficiency for the chain transmission.
3. See Section 2.2.3 for the estimated efficiency for the gear transmission.

2.2 Generators

The selection of a generator for a manually-driven power unit depends upon its simplicity, compactness, performance characteristics (such as its efficiency and speed at which it must be driven), control, and cost. The two basic types of generators are alternating current (AC) alternators and direct current (DC) generators.

2.2.1 AC Alternators

Alternators generally have the armature as the stator or stationa y member, and the field as the rotating member. These alternators are categorized according to the method of field excitation; such as (1) externally excited, (2) self-excited, and (3) permanently excited.

The externally excited alternator is generally designed for power plants. The excitation current, which is low voltage DC, is carried through slip rings which are easily insulated at these voltages. The power required to excite the field windings is less than 1-1/2 percent of the rated power of the machine. The simplest manner of achieving control is through a rheostat in the field circuit. The rheostat controls the field current, and thus the magnetic flux-density.

The self-excited generator is designed for the intermediate power range, the smallest being rated at approximately 200 watts. This machine uses a portion of the output voltage, which is carried through slip rings, although residual magnetism in the field is required to initially induce a voltage in the armature at start-up.

The permanently excited alternator has magnets in the field which produce a magnetic field of constant strength. These alternators are normally designed for the low power output range (up to 250 watts) and have linear speed-voltage characteristics. Since the field is permanently excited, these machines have no slip rings and the output voltage is solely dependent on the speed at which the alternator is driven. There are two types of permanently excited alternators. One type has a rotor containing permanent magnets with the armature windings located in the stator; while the second type, called a flux switch alternator, has both the permanent magnets and the armature windings located in the stator. The rotor in this case merely provides the magnetic flux path between the positive and negative poles of the magnets. This flux path also passes through the armature windings. As the angular position of the rotor is changed, the flux alternately passes through the rotor from one set of poles to the next set of poles. As the flux alternates between the magnetic poles of the stator, a reversal of the direction of the flux through the armature windings occurs, thereby inducing a voltage in these windings. The flux switch alternator is primarily designed for high speed, high frequency applications, and is most efficient under these conditions.

2.2.2 DC Generators

The construction of the DC generator is somewhat different than the AC alternator. In this case, the armature is the rotating member and the field is located in the stator or stationary member. The DC generator, however, operates in the same manner as the AC alternator; i.e., a voltage is generated in the armature windings with an alternating waveform. The distinct difference in the two machines is in the delivery of the voltage to the load. In the AC machine, the waveform appearing at the load is the same as that in the winding, but in the DC machine, one-half of the wave is reversed by the commutator. With sufficient coils spaced around the armature, the ripple in the voltage is reduced to an insignificant quantity in the practical machine. There are three standard types of DC generators: the shunt generator, the series generator, and the compound generator.

The field of the shunt generator in series with its rheostat is connected directly across the armature. The rheostat, or voltage regulator, controls the strength of the field in order to regulate the output terminal voltage. Shunt generators are commonly used in city power substations. This type of generator, in addition to an AC alternator with a built-in rectifier, also has wide application in the automotive and truck industry and is designed for 6, 12, and 32 volt systems.

In the series generator, the entire load flows through the field winding, which consists of relatively few turns of wire of sufficient size to carry the entire load current without undue heating. This generator supplies constant current, and has been used to operate series arc lamps.

By addition of a series winding to the shunt generator, a constant terminal voltage may be automatically maintained. This generator is known as a compound-wound generator and is chiefly used to supply a pure motor load subject to rapid fluctuations, such as in railway work.

2.2.3 Generator Analysis

The permanently excited alternator is best suited for the power unit of a shelter lighting kit since this machine is inexpensive, compact, requires the least maintenance, and can be used on fluorescent lighting systems. The impedance of the armature windings can be designed to provide both the necessary cathode heating amperage for starting fluorescent lamps, and the required operating amperage after starting, without changing the speed of the alternator. This alternator can also be short-circuited repeatedly without damage to the armature windings.

The permanent magnet rotor alternator is best for a manually-powered application. This type of alternator is designed for slower speeds; whereas the flux switch alternator is designed for high speeds (2,000 to 100,000 rpm), and requires complex transmissions and speed increasers. The optimum trade-off speed for a permanent magnet rotor alternator and its transmission is approximately 1800 to 2100 rpm. Higher speeds reduce the cost of the alternator, but increase the transmission costs. Slower speeds result in a larger, more expensive and less efficient alternator. Considering a pedal speed of 55 rpm, an alternator speed of 2,000 rpm would require a transmission speed ratio of 36.4 to 1.

The four basic types of transmissions that can achieve this 36.4 to 1 speed ratio are belt-drives, friction drives, chain drives, and gear drives. The belt and friction drives are too inefficient for a manually-driven application with low power inputs (Ref. 12); therefore, the transmission is limited to either gear or chain drives. The efficiency of a 36.4 to 1 chain transmission driven at 2,000 rpm is approximately 80 percent (Ref. 13); while the efficiency of a similar gear transmission is estimated to be at least 90 percent. The overall efficiency of the alternator and transmission must be determined by test. After prototypes have been built, the transmission should be selected based on cost and the overall size and volume of the lighting kit package.

Although the shunt-wound DC generator, which is mass-produced for vehicle manufacturers, costs less than a permanent magnet generator produced in small quantities, the disadvantages of using this type of generator in a lighting kit are: 1) the lighting system would be limited to incandescent lamps which produce approximately one-sixth the light output of fluorescent lamps, 2) larger capacity wiring looms would be required to carry the high currents of a low voltage system, 3) the transmission would be more expensive since these generators are designed to operate at speeds from 2,000 to 10,000 rpm, and 4) the power losses in the generator windings and the voltage regulator are comparatively high due to the large currents. It is possible to operate fluorescent lamps from a DC circuit; however, a polarity reversing switch, a special ballast, a resistor, and a transformer are required. These accessories would consume a substantial amount of power. For instance, a 40-watt lamp would have an additional 44 watt power loss in the accessories for a total required power input of 84 watts.

The single advantage of a low voltage DC system is that electrical energy can be stored in a battery so that power is available at all times. The significance of this method is that lighting can be provided at night and other times when it is not desirable to operate the generator. The disadvantages of interposing a lead-acid battery between a DC generator and the load, or a battery and battery charger between an AC generator and the load, are as follows:

(1) The efficiency of either system is reduced since the watt-hour efficiency of lead-acid batteries is approximately 77 percent. Normally, the rated discharge for a battery is based on eight hours; therefore, a 40 ampere-hour battery (typical 12 volt automobile battery) would deliver approximately 60 watts for 8 hours until completely discharged and require a recharge rate of 71 watts for 8.8 hours. Increased discharge rates would

reduce the ampere-hour rating and the watt-hour efficiency of the battery.

The use of a battery charger in conjunction with a 120 volt AC generator will further reduce the system efficiency. Battery chargers have an efficiency of 65 to 75 percent; thus, producing an overall efficiency for the battery/battery charger combination of 50 to 55 percent.

(2) As stated previously, the typical automobile generator is not practical for a manually-powered application, since it is designed for large power outputs at high speed and is relatively inefficient, particularly with light loads or low speed. For example, the Leece-Neville type A001-6000 generator has an output of 54 watts at 1000 rpm with an input of 0.37 horsepower. The generator for a manually-powered application would therefore have to be specially designed and would cost more than a similar 120 volt AC generator.

(3) The cost of the components for the low voltage DC system will be substantially increased due to the special DC generator, the lead-acid battery, battery charger, and the increased wire size necessary to carry the current at this low voltage.

2.3 Experimental Evaluation

An experimental power unit was fabricated to evaluate the concepts of manually generating electrical power with a permanent magnet generator for operation of fluorescent lamps, incandescent lamps, and other accessories.

2.3.1 Description of Experimental Unit

The experimental unit consisted of a commercially available generator mounted to a VK (Ventilation Kit) frame and transmission (see Figure 1).

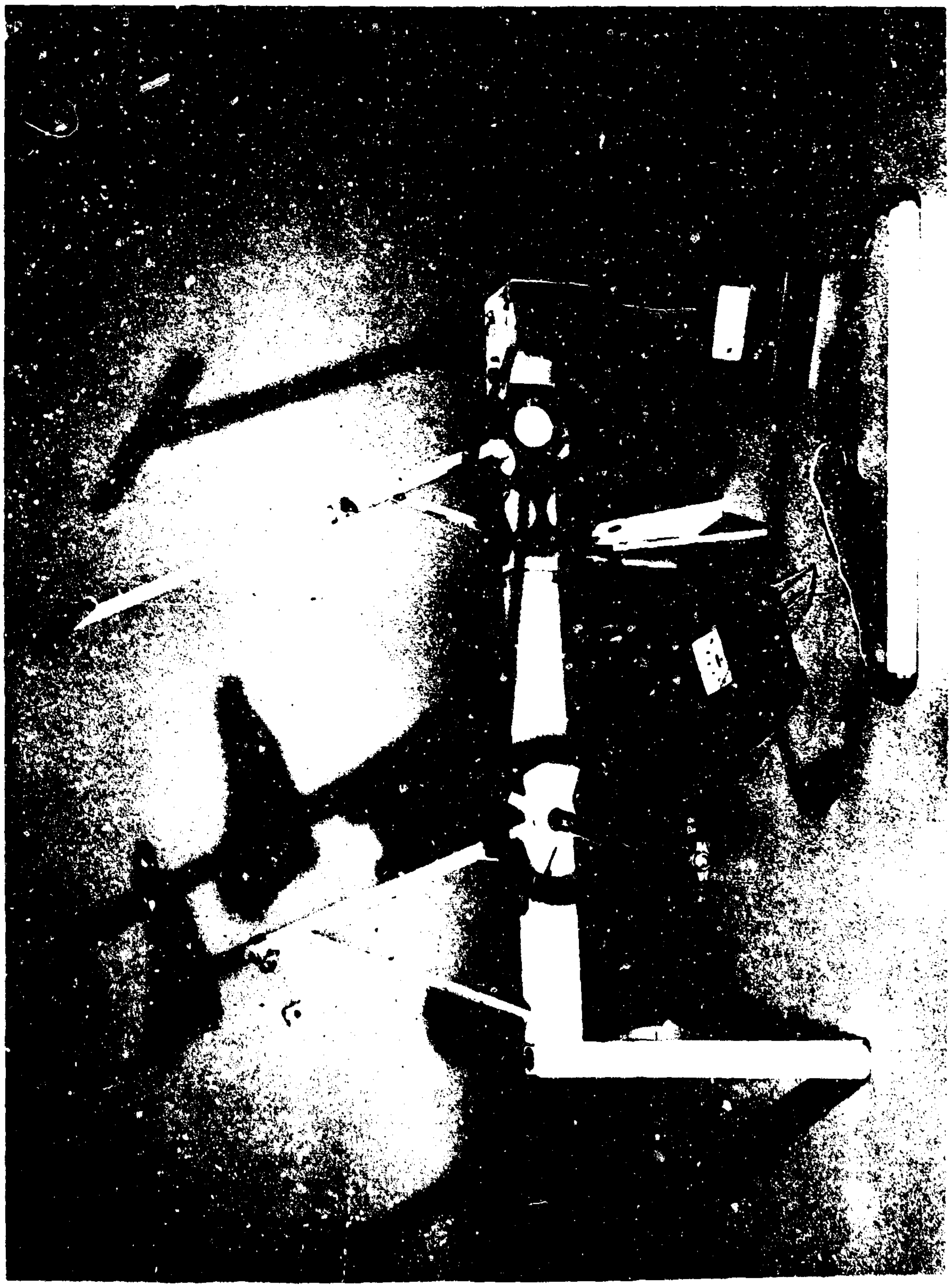


Figure 1 Experimental Power Unit

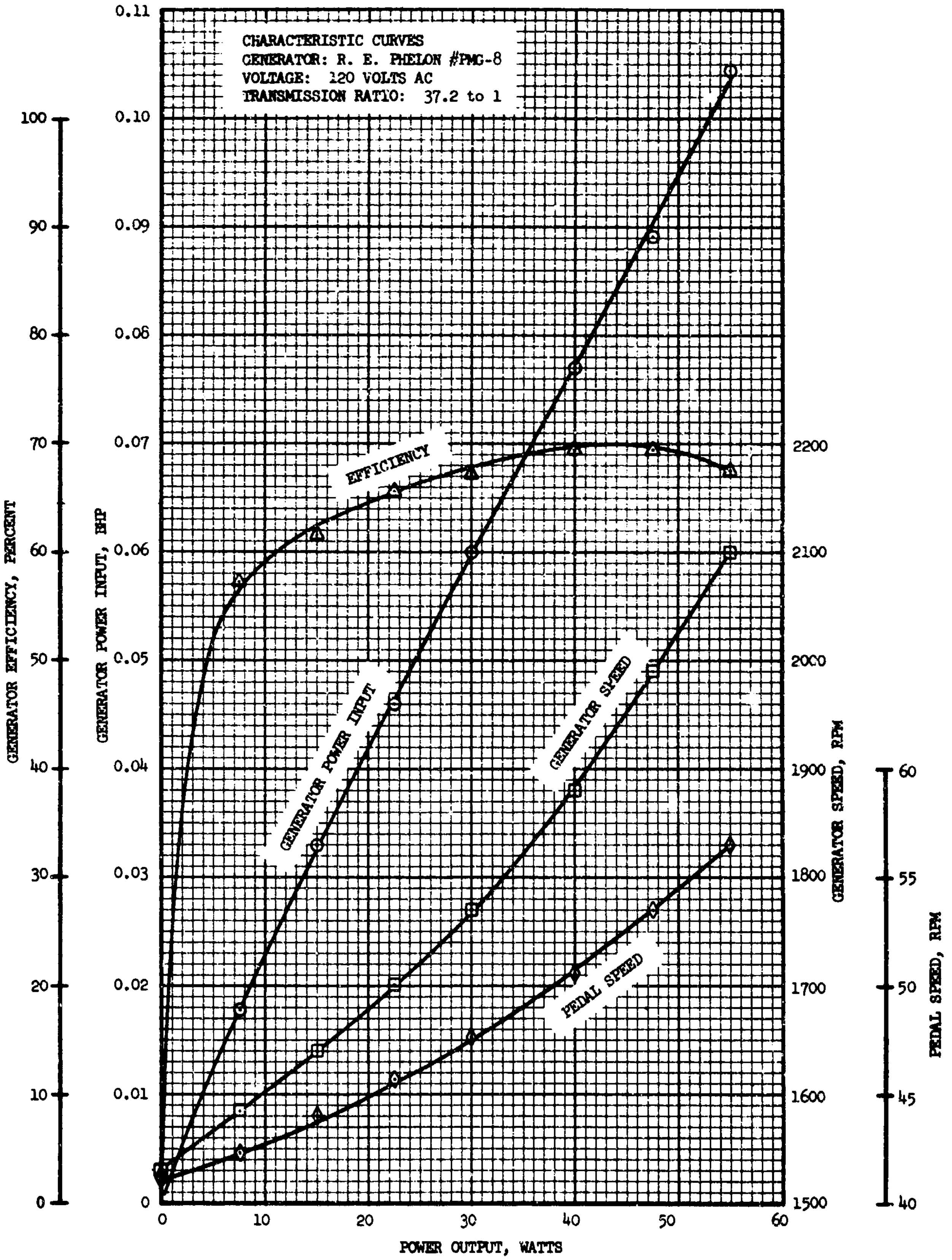


Figure 2 Experimental Generator Performance

The generator was an eight pole, alternating current (AC), alternator with a permanent magnet rotor containing stabilized Alnico magnets and a stator wound specially for a 120 volt output (see Section 2.3.2) at 50 watts and 2000 rpm. The performance of this generator at a constant voltage output of 120 volts for various generator loads is shown in Figure 2. Since the standard generator was furnished with a pedestal mount, an adapter bracket was fabricated for mounting the generator to the frame of the VK assembly. The original VK transmission was modified to increase the speed ratio from 19.46/1 to 37.20/1 in order to obtain pedal speeds between 40 and 54 rpm at corresponding power outputs of 0 and 50 watts.

2.3.2 Lighting

The preheat fluorescent lamps from 4 through 40 watts and the 30 watt rapid-start lamp were operated individually without standard ballasts by using the experimental power unit as the power source and as the circuit ballast (see Figure 3).

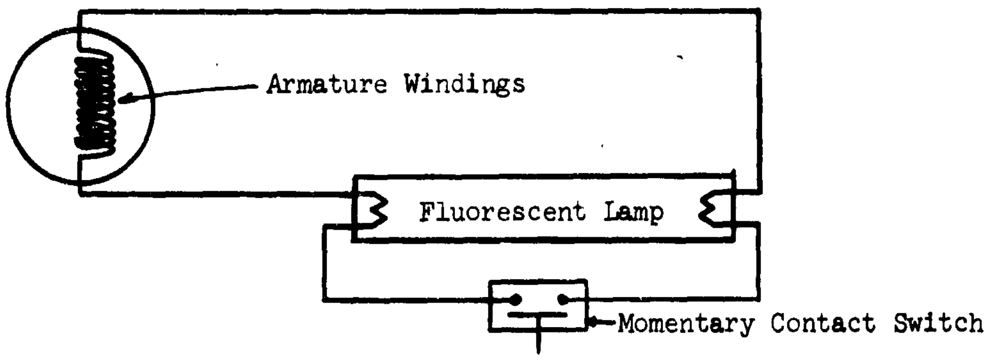


Figure 3 Experimental Power Circuit, 1 Lamp

A momentary contact-type manual switch was used to start the lamps. With the switch closed, a heating current passes through the cathodes at each end of the lamp, heating them, and causing electrons to be ejected from the cathode by thermionic emission. Upon opening the switch, a transient voltage provided by the armature windings of the generator is impressed across the cathodes of the lamp causing an electric discharge through the tube to start the lamp. The lamps were also started with either the thermal-switch or the glow-switch automatic starters. The glow-switch starter is preferred for the lighting kit, since this starter consumes no power, while the thermal-switch starter consumes 1/2 to 1-1/2 watts during lamp operation. The voltages required to sustain operation of the lamps are indicated in Table I.

Pairs of 4, 6, 8, 14, 20 and 25 watt preheat lamps were operated in series utilizing the glow-switch automatic starters (see Figure 4). With this circuit, the terminal voltage of the generator is the summation of the individual lamp operating voltages; for example, in the case of the 20-watt lamps, the terminal voltage would be 110 volts.

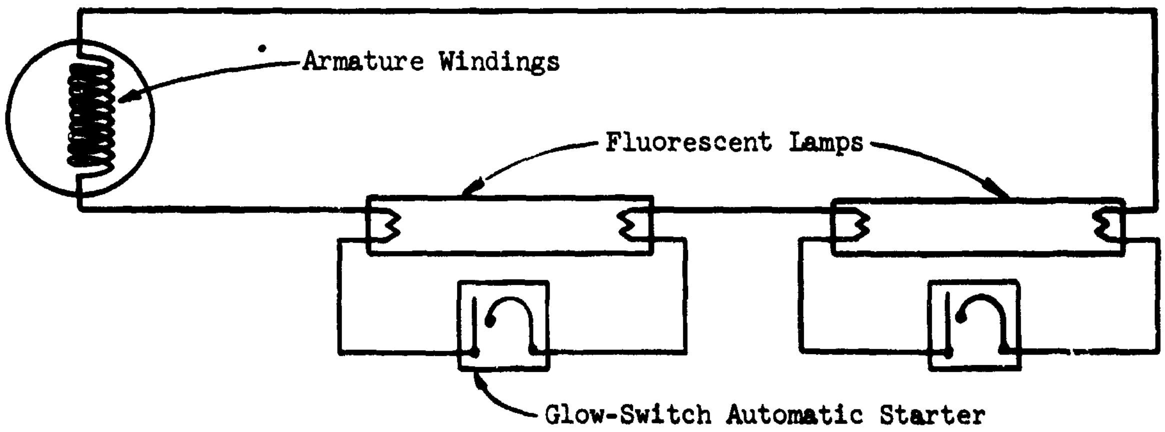


Figure 4 Experimental Power Circuit, 2 Lamps in Series

Pairs of 13, 30, and 40-watt preheat lamps could not be operated in series, since the necessary operating voltages are approximately 200 volts. This voltage is beyond the capability of the experimental power unit. In addition, the 30-watt rapid-start lamps could not be operated for the same reason. This lamp requires an operating voltage greater than 150 volts.

Since the generator output voltage is the summation of the individual lamp voltages when operating fluorescent lamps in series, two 20-watt lamps or two 25-watt lamps in series would require operating voltages of 110 volts and 120 volts, respectively, which are approximately the same as the voltage required for operating incandescent lamps, which can be readily operated with the experimental unit. Therefore, the recommended design voltage for the power unit is 120 volts.

2.3.3 Voltage Regulation

Fluorescent lamps that were operated with the experimental unit at power inputs less than their rated values showed a distinct "flicker". It is possible to operate a lamp at a point at which the flicker just becomes apparent. This provides the operator with a visual indication of the pedal speed necessary to keep the lamp operating. A simpler and more direct method, however, is the use of a voltmeter to maintain the correct output voltage. A voltmeter calibrated between 0 and 150 volts AC was, therefore, attached to the experimental power unit to provide a direct readout to the operator of the generator terminal voltage. This method of voltage control allows the operator to readily change pedal speed to compensate for fluctuations in output voltage due to changing loads. Therefore, a voltmeter is recommended for the power unit of the lighting kit. The significance of the voltmeter is increased if an optional incandescent lighting system is included in the kit.

SECTION 3

DESIGN

The basic lighting kit includes a power unit and a fluorescent lighting system. An incandescent lighting system is proposed as an optional accessory which may be used to provide night lighting or background illumination in multi-room shelters. The output voltage of the power unit is 120 volts AC which is the standard household current, thus permitting operation of not only fluorescent and incandescent lighting sytems, but also equipment such as radio receivers and dry-cell battery chargers which may be included in future shelter supplies.

3.1 Basic Lighting Kit

3.1.1 Power Unit

Two power unit designs are recommended for further development to establish which unit should be used in the shelter lighting kit. The development of both designs is necessary to determine their overall efficiency and performance, and to finalize their costs. One unit utilizes a roller chain and sprocket transmission while the other has a generator with an integral geared transmission. Both units were designed for one-man operation at a nominal power input of 0.10 horsepower at a pedal speed of 55 rpm. These human factors data were established during the development of the shelter ventilation kit (Ref. 14).

3.1.1.1 Roller Chain Transmission Design

The power unit with an external roller chain transmission is shown in Figure 5. This design is basically a unitized version of the shelter ventilator design. The main structural member is the horizontal "spine". This beam member is fabricated from 2 inch by 3 inch rectangular steel tubing. The saddle mast and mast support are welded to the spine to provide the same saddle-to-pedal angle and dimensions as those of a standard bicycle. The rear stand consists

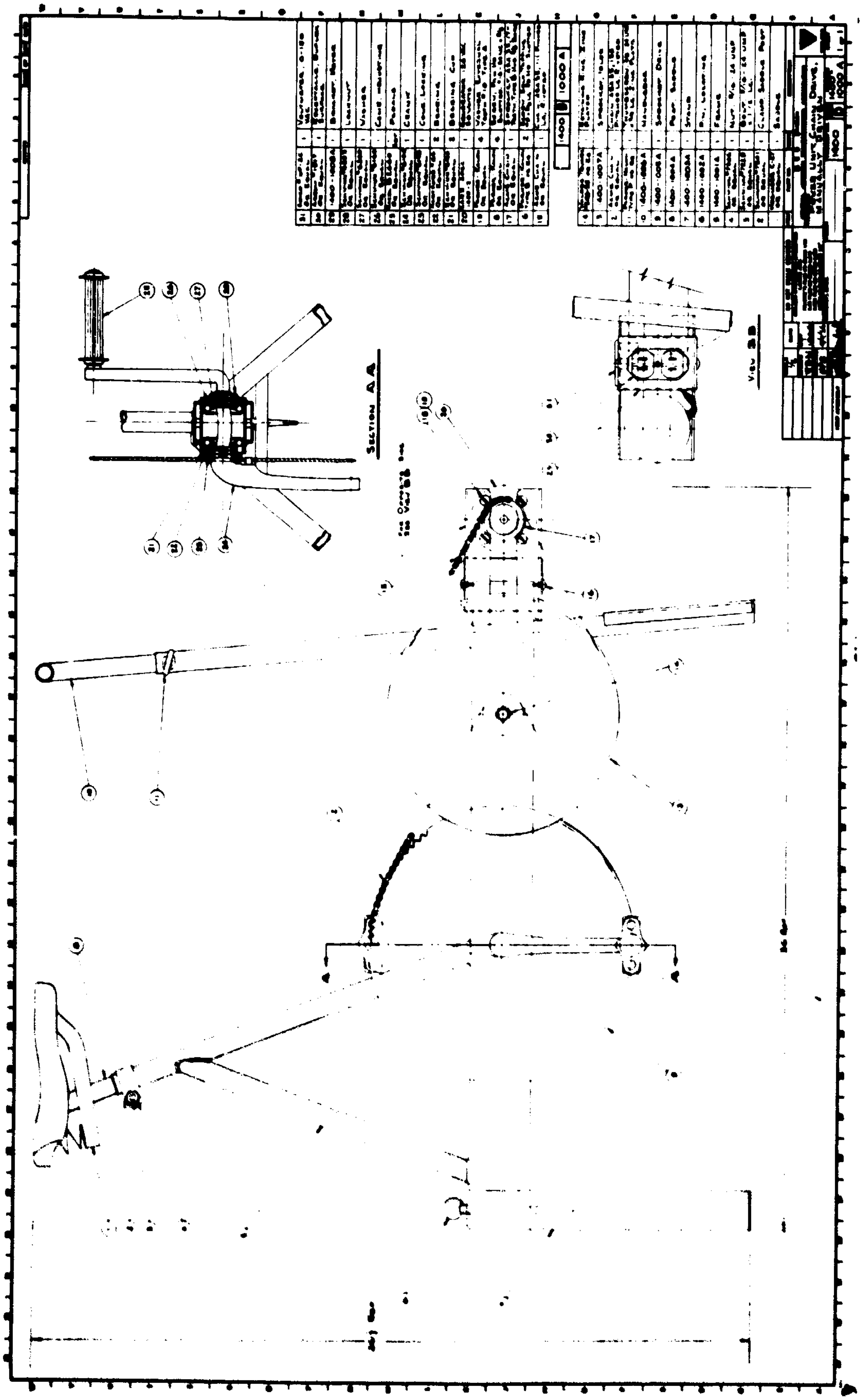


Figure 5 Power Unit With an External Roller Chain Transmission

of a steel channel shaped in an "A" frame and attached to the spine by a removable pin. The stand is designed for removal to reduce the overall dimensions for packaging purposes. The handlebar housing provides the forward support for the frame. The handlebar slides inside this housing and can be removed for packaging purposes. Height adjustment is provided by a thumbscrew. The actual height of the saddle can be adjusted by loosening the mast clamp and moving the saddle post to the desired position.

The generator is an eight pole alternating current machine with a wound stator and a permanent magnet rotor. The generator is rated at 120 volts AC and 50 watts at a nominal speed of 2000 rpm. The stator housing is flanged for mounting to the support bracket at the end of the spine. The rotor of the generator is supported by two ball bearings which are sealed and lubricated for the life of the unit The two output lead wires of the generator are connected to a duplex outlet receptacle through a 0-150 volt AC voltmeter. Both the receptacle and voltmeter are mounted on a bracket attached to the spine.

The transmission between the crank and the generator shaft requires a two-speed step-up. The roller chain used in the transmission is American Standards Association (ASA) No. 35 with a pitch of 3/8 inch. This chain is used rather than 1/2 inch pitch standard bicycle chain to reduce the size of the sprockets and the centerline distance between sprockets. The sprockets for the transmission are attached either directly to the crank or to an idler shaft which is welded to the spine. The crank assembly and pedals are standard bicycle parts. This crank assembly is mounted in a tubular hanger which is welded to the spine. The sprocket at the crank has 112 teeth and is coupled with a chain to a 17 tooth sprocket at the idler shaft. Welded to this 17 tooth sprocket is a 96 tooth sprocket which is coupled to the 17 tooth sprocket on the generator shaft by a second chain. This results in a transmission speed ratio of 37.2 to 1. This design requires a package size of 37 inches by 37 inches by 18 inches. The drawings required to fabricate a preproduction unit are presented in Appendix A.

3.1.1.2 Integral Transmission Design

The power unit using a generator with an integral transmission is shown in Figure 6. This design features a collapsible tripod stand, adjustable handlebar and saddle, and the generator with attached cranks and transmission. A 2 inch by 1 inch by 1/8 inch steel channel provides the forward leg and main structural member of the tripod frame. Welded to the top of this channel is a 3/16 inch thick steel plate which contains the hinges for the rear support legs and the mast for the saddle post. Hinged steel pads are provided at the base of all three legs to distribute the downward force. The generator mounting bracket and the handlebar housing are welded to the forward leg or channel. All three legs are connected with a wire cable to limit the spread of each leg and to add rigidity to the framework.

The generator and gear transmission are contained in one housing which is provided with a pedestal mount. The generator is rated at 120 volts AC and 50 watts at a 55 rpm input to the transmission shaft. The transmission requires no lubrication after assembly and the complete unit has a storage life of at least ten years. Two standard "3-piece" bicycle cranks are attached to the transmission input shaft.

The generator lead wires are connected to the voltmeter and duplex receptacle which are both mounted on the meter bracket. The voltmeter is calibrated between 0 and 150 volts AC and the duplex receptacle provides two separate circuits for parallel operation.

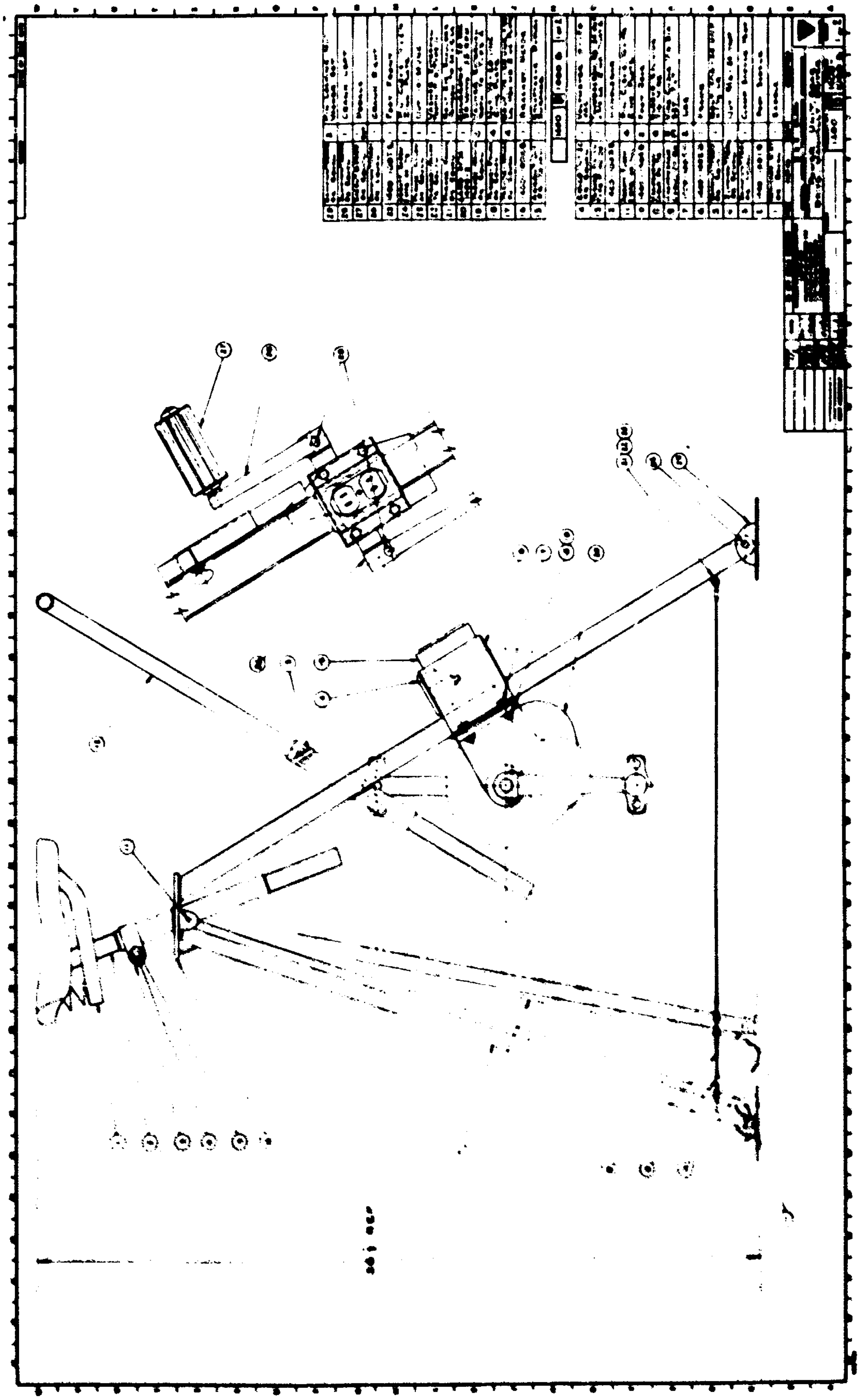


Figure [illegible] Power Unit With an Integral Geared Transmission

This design requires a package size 45 inches by 18 inches by 14 inches. The drawings required to fabricate a preproduction unit are presented in Appendix B.

3.1.2 Fluorescent Lighting System

The fluorescent lighting system consists of two preheat fluorescent lamps and two lamp fixtures. The rating of the lamps to be furnished with the kit is subject to verification of the transmission efficiency of the selected power unit. It is expected that two 20-watt lamps would be furnished for the power unit with a roller chain and sprocket transmission, and two 25-watt lamps for the power unit, which has a generator with an integral geared transmission.

Two adjustable fixtures with cords are furnished with each kit. The fixtures, shown in Figure 7, can be adjusted to accept 15 through 40 watt lamps, which range in length from 18 to 48 inches. Each fixture contains an automatic starter of the glow-switch type. One fixture has a female receptacle at one end, for connecting the second fixture in series, and a 20-foot long cord with a molded male plug at the other end. This fixture is only used when operating two fluorescent lamps in series. The second fixture has a 100-foot electrical cord with a molded male plug. This fixture has no female receptacle and is used either singly or in series (see Figure 8). The fixture is designed to accommodate a 40-watt lamp, since in most cases, this size lamp is more likely to be found in the shelters if the stocked lamps are broken. The lengths of the cords attached to each fixture should be verified by additional analysis of shelter sizes and configurations (Ref. 15). Both electrical cords are 2-wire, 18 gage, SPT type which is the minimum wire gage suitable for these lengths and connections. The fixture with the 20-foot cord is intended for use at the ceiling of the room in which the power unit is located. The other fixture with the 100-foot

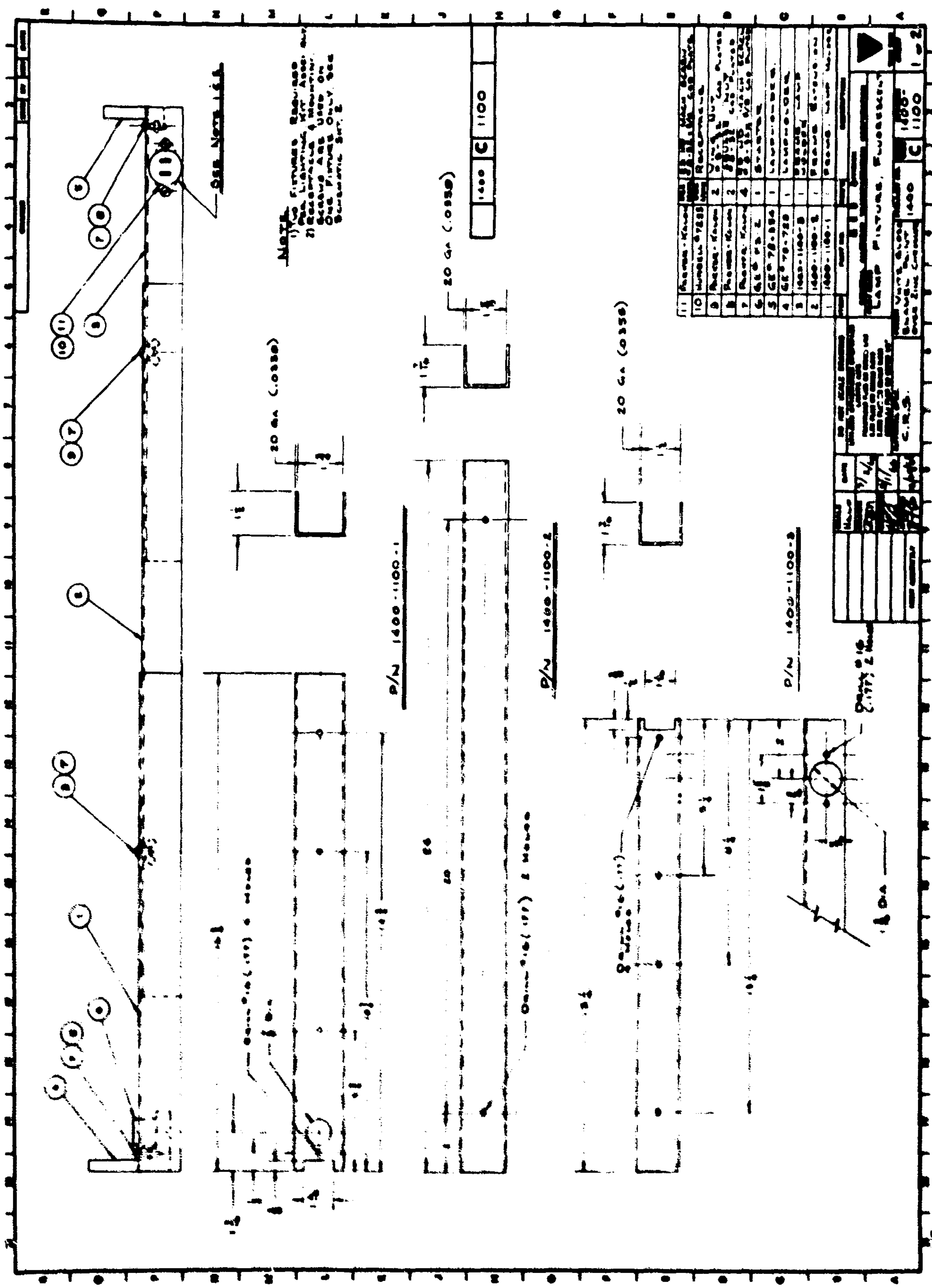


Figure 7 Adjustable Fluorescent Fixture

cord is intended for use in an adjacent room in the shelter.

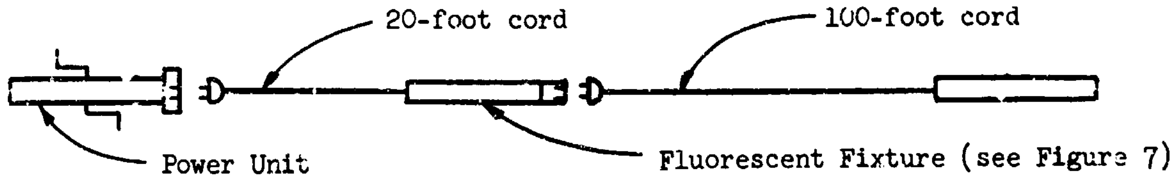


Figure 8 Fluorescent Lighting System

3.1.3 Cost Analysis

The cost of the basic lighting kit using a power unit with a roller chain transmission is $90, based on a production of 100,000 units (see Table V). The cost of a lighting kit with a power unit having a generator with an integral geared transmission ranges from $88 to $111 (see Table VI). This variation is due to the estimated production cost of the generator with an integral geared transmission. Based on firm quotations from manufacturers (Refs. 16 and 17), this cost is between $30 and $50 depending on whether economical production techniques such as powdered-metal gears, nylon gears, sleeve bearings, etc. can be used. A closer estimate is not possible at this time without a complete engineering design and production cost evaluation by the generator manufacturers.

3.2 Accessory Incandescent Lighting System

An analysis of shelter sizes, configurations, and human factors should be conducted to determine if an incandescent lighting system is warranted as an accessory of the lighting kit, since this type of lighting might be used advantageously in multi-room shelters as background illumination. This type of lighting can also be used to supply low level night illumination for sleeping at a very minimum cost. The incandescent lighting system is therefore proposed as an optional accessory and, if adopted, would consist of the following items in addition to the fluorescent lighting system (see Figure 9):

(1) Five (5) extension cords, type SPT, 2-wire, 18 gage, with molded male

TABLE V

Cost Analysis of Lighting Kit Using a Power Unit With

A Roller Chain Transmission

Purchased Parts & Material: . . . . $ 46.58

Drawing No. & Item	Description	Cost
1400-1 00A Item 1	Saddle	$0.87
Item 2	Clamp, Saddle Post	0.09
Item 3	Bolt	0.04
Item 4	Nut	0.02
Item 11	Thumbscrew	0.022
Item 12	Chain, 130 Pitches	2.25
Item 14	Retaining Ring	0.005
Item 15	Chain, 111 Pitches	1.92
Item 16	Screw	0.02
Item 17	Sprocket	0.42
Item 18	Screws	0.04
Item 19	Washers	0.02
Item 20	Generator	20.00
Item 21	Bearing Cup	0.22
Item 22	Bearing	0.094
Item 23	Cone, Locking	0.128
Item 24	Crank	1.40
Item 25	Pedals	0.46
Item 26	Cone, Adjusting	0.128
Item 27	Washer	0.011
Item 28	Locknut	0.048
Item 30	Receptacle	0.38
Item 31	Voltmeter	1.44
1400-1001A	Nut, Weld	0.034
1400-1005A	Sprocket	2.91
1400-1007A	Sprocket	3.14
1400-1001A (material)	Frame	2.65
1400-1002A (material)	Pin, Locating	0.22
1400-1003A (material)	Stand	0.49
1400-1004A (material)	Post, Saddle	0.29
1400-1006A (material)	Handlebar	0.82
1400-1008A (material)	Bracket, Meter	0.14
	Lamp Fixtures (2)	1.80
	Lamps, Fluorescent (2)	1.02
	Starters (2)	0.24
	Wiring Loom, 20 Feet	0.65
	Wiring Loom, 100 Feet	2.25

Packaging: . . . . $ 9.00

Inner Box, Triple-Wall (PPP-B-640)		3.80
Bag, Barrier (MIL-B-131, Class 1)		3.[illegible]
Exterior Container (PPP-B-636)		[illegible].83

Finishing: . . . .$ 5.70

1400-1005A	Sprocket	0.40
1400-1007A	Sprocket	0.40
1400-1001A	Frame	3.50
1400-1002A	Pin, Locating	0.05
1400-1003A	Stand	0.60
1400-1004A	Post, Saddle	0.20
1400-1006A	Handlebar	0.50
1400-1008A	Bracket, Meter	0.05

Labor: . . . .$ 8.12

Arc Welding	5.75
Machining & Assembly	2.37

Labor Overhead: (100%). . . . . $ 8.12

Sub-Total 77.62

General & Administrative Services: (8%). 6.21

Sub-Total 83.83

Profit: (7%) 5.87

TOTAL $89.70

NOTES: 1) Based on 100,000 units.
2) No freight costs included.

TABLE VI

Cost Analysis of Lighting Kit Using a Power Unit With
A Generator Having an Integral Geared Transmission

Purchased Parts & Material: . . . . $46.23 - $66.23

Drawing No. & Item	Description	Cost
1400-1000B Item 1	Saddle	$0.87
Item 3	Clamp, Saddle Post	0.09
Item 4	Nut	0.02
Item 5	Bolt	0.04
Item 8	Wire Cable	0.27
Item 9	Sleeve, Splicing	0.12
Item 11	Pin, Clevis	0.24
Item 13	Thumbscrew	0.022
Item 14	Voltmeter	1.44
Item 15	Receptacle	0.38
Item 17	Bolt	).08
Item 18	Nut	0.04
Item 19	Washer	0.005
Item 20	Generator	30.00-50.00
Item 21	Bolt, Eye	0.043
Item 22	Washer	0.002
Item 23	Nut	0.004
Item 24	Pin, Clevis	0.06
Item 26	Crank, Right	1.20
Item 27	Pedals	0.46
Item 28	Crank, Left	1.20
Item 29	Pin, Nut, Washer set	0.10
1400-1002B	Nut, Weld	0.034
1400-1001B (material)	Post, Saddle	0.19
1400-1002B (material)	Frame	1.21
1400-1003B (material)	Leg	0.88
1400-1004B (material)	Foot, Rear	0.22
1400-1005B (material)	Handlebar	0.82
1400-1006B (material)	Bracket, Meter	0.12
1400-1007B (material)	Foot, Front	0.11
	Lamp Fixtures (2)	1.80
	Lamps, Fluorescent (2)	1.02
	Starters, (2)	0.24
	Wiring Loom, 20 Feet	0.65
	Wiring Loom, 100 Feet	2.25

Packaging: 4.76

Inner Box, Triple-Wall (PPP-B-640)	2.09
Bag, Barrier (MIL-B-131, Class 1)	1.72
Exterior Container (PPP-B-636)	0.95

Finishing: 5.75

1400-1001B	Post, Saddle	0.35
1400-1002B	Frame	3.50
1400-1003B	Leg	0.80
1400-1004B	Foot, Rear	0.30
1400-1005B	Handlebar	0.50
1400-1006B	Bracket, Meter	0.10
1400-1007B	Foot, Front	0.20

Labor: 9.67

Arc Welding	7.80
Machining & Assembly	1.87

Labor Overhead: (100%) 9.67

Sub-Total. . . . . 76.08 - 96.08

General & Administrative Services: (8%). . . . . 6.09 - 7.69

Sub-Total. . . . . 82.17 - 103.77

Profit: (7%) . . . . 5.75 - 7.26

TOTAL . . . . . . $87.92 - $111.03

NOTES: 1) Based on 100,000 units.
2) No freight costs included.

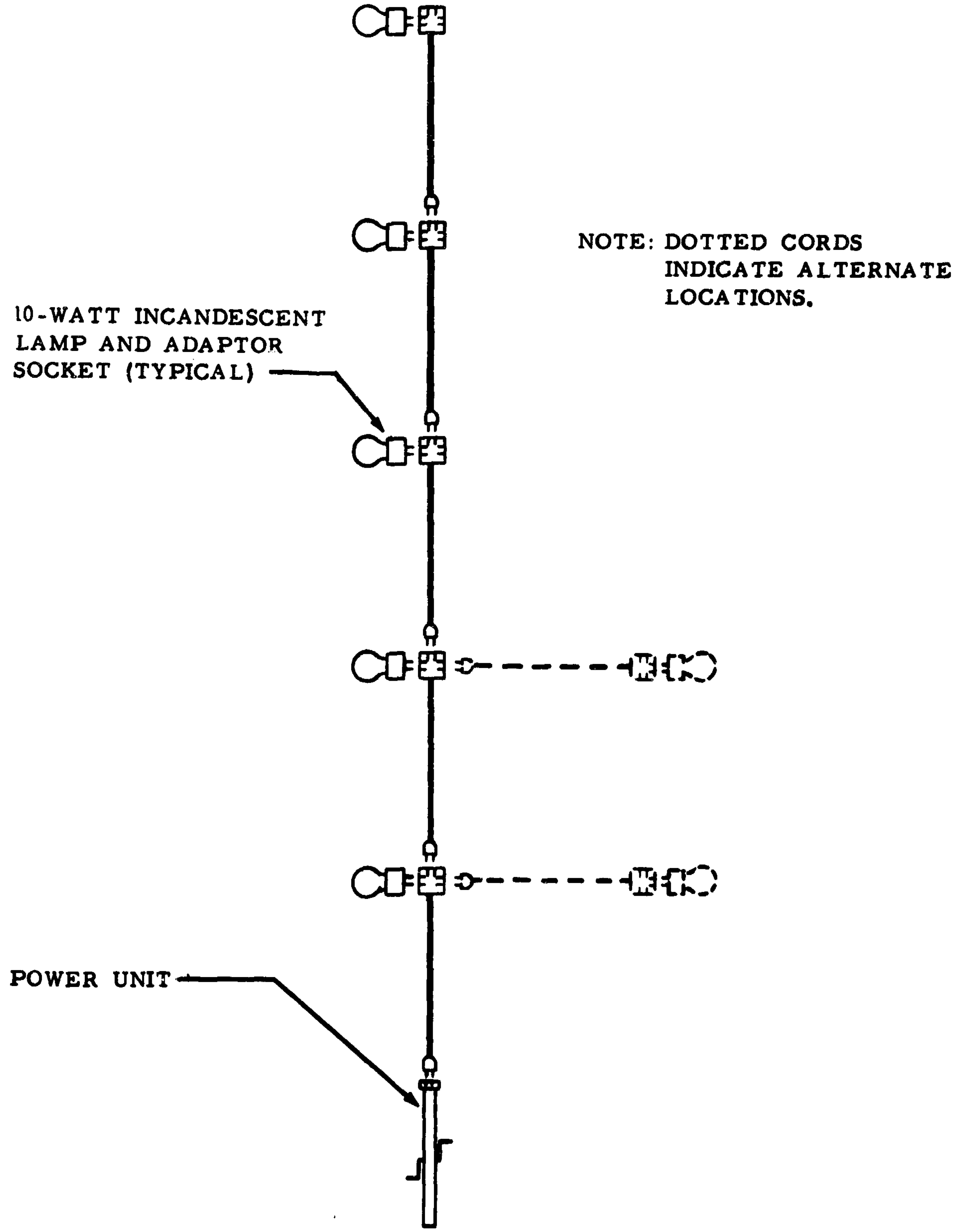


Figure 9 Incandescent Lighting System

plug, 115 volt, 15 ampere at one end, and a cube tap, molded, 125 volt, 15 ampere at the other end. The length of the cords is subject to an analysis of shelter sizes and configurations (Ref. 15).

(2) Five (5) bakelite adaptor sockets, 660 watt, 125 volt, medium base.

(3) Five (5) 10-watt incandescent lamps.

The electrical ratings for the cords and adaptors are minimum for the possible lengths of wire and connections as shown in Figure 9.

The estimated cost of this system is $7.30 based on original equipment manufacturer's cost for 100,000 units of the following items.

Item	Quantity Required	Total Cost
Extension Cord, 50 feet	5	$ 6.25
Adapter Socket	5	0.50
Incandescent Lamp, 10-watt	5	0.55
	Total	$ 7.30

REFERENCES

1. Smith, M. C. and Wendel, W. J., "Illumination In Group Shelters", Part I, prepared for the Office of Civil Defense under Contract OCD-OS-62-80, Sanders and Thomas, Inc., Pottstown, Pa., January 1963, p. 33.

2. Ibid, Part II, March 1963.

3. Fabuss, B. M. and Barsanyi, A. S., "Self-Contained Generator for Shelter Use", prepared for the Office of Civil Defense under Contract OCD-PS-64-7, Monsanto Research Corporation, Boston Laboratory, Everett, Massachusetts, October 1964.

4. Lauck, F. W., et. al., "Small Auxiliary Power Systems", prepared for the Office of Civil Defense, under Contract OCD-OS-62-282, A. O. Smith Corp., Long Range Research Laboratory, Milwaukee, Wisconsin, May 1964.

5. "Improvised Power Supplies", prepared for the Office of Civil Defense under Contract OCD-OS-62-281, The General Electric Company, Military Communications Department, Nuclear Effects Product Engineering, Syracuse, New York, June 1964.

6. Libovicz, B. A. and Behls, H. F., "Shelter Package Ventilation Kit", prepared for the Office of Civil Defense under Work Unit 1423A, Contract OCD-PS-64-22, General American Transportation Corporation, (GARD Report 1244), Niles, Illinois, October 1965.

7. Illuminating Engineering Society, "IES Lighting Handbook", Third Edition, 1959, New York, Section 8.

8. Neveril, R. B., Private Communication with P. Finstad, General Electric Company, December 1966.

9. Op. Cit., "IES Lighting Handbook".

10. General Electric Form 2195, "Large Lamp Price Schedule", Effective November 1, 1965.

11. Neveril, R. B., Private Communication with A. Hook, General Electric Company, December 1966.

12. Op. Cit., "Improvised Power Supplies",pp. 9-12.

13. Op. Cit., Libovicz, B. A., GARD Report 1244, p. 60.

REFERENCES (CONT'D)

14. Libovicz, B. A. and Behls, H. F., "Experimental Prototype Package Ventilation Kit, First Structural and Human Factors Test", prepared for the Office of Civil Defense under Stanford Research Institute Subcontract No. B-70925(4949A-28)-US, General American Transportation Corporation (GARD Report 1278-4.1), Niles, Illinois, May 1965, p.4.

15. Hill, E. L., et. al., "Determination of Shelter Configuration for Ventilation", prepared for the Office of Civil Defense under Work Unit 1235A, Contract OCD-PS-64-56, Research Triangle Institute (RTI Report R-OU-177), Durham, N. C., July 1965.

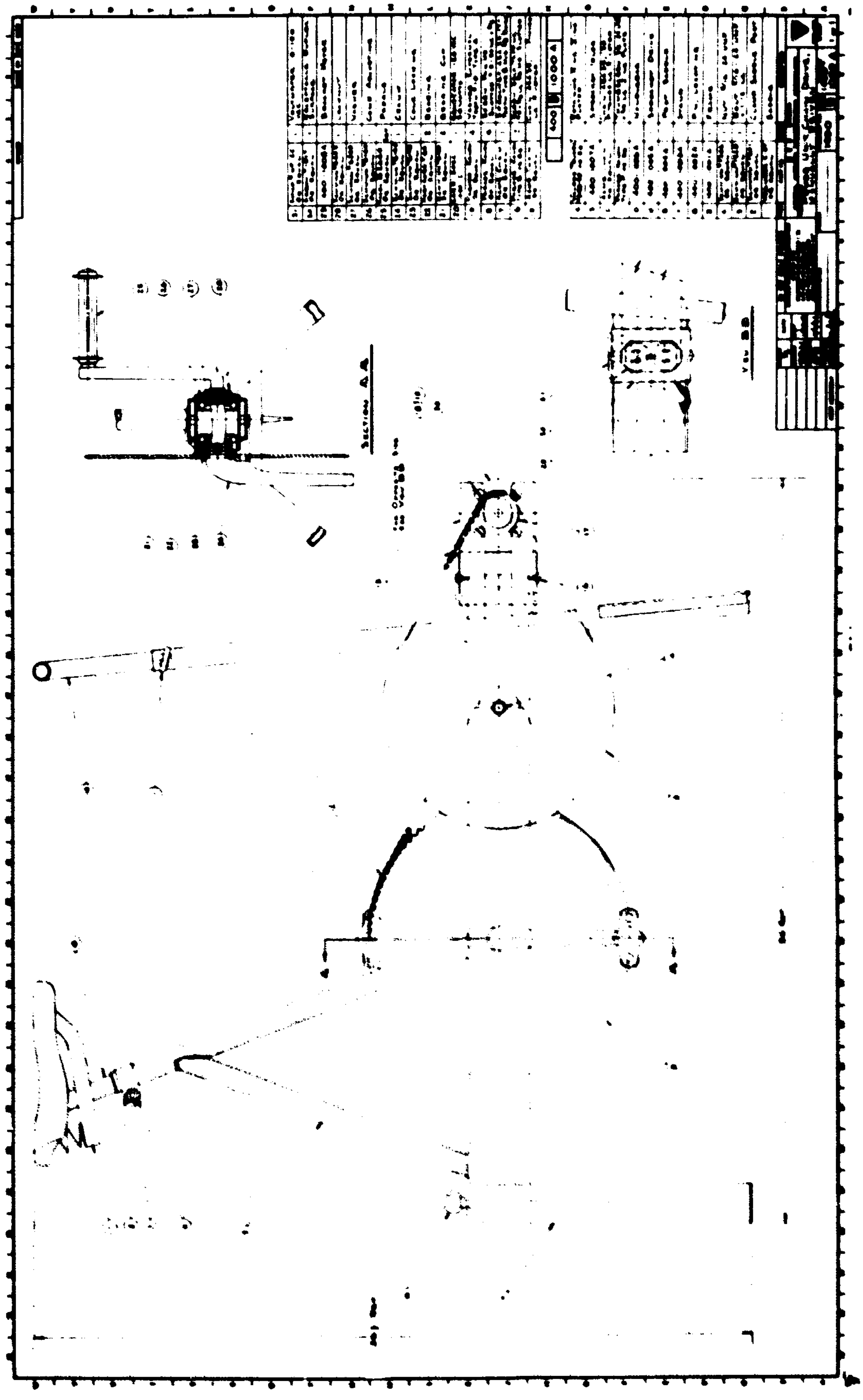
16. Globe Industries, Inc., Dayton, Ohio, Quotation dated August 31, 1966.

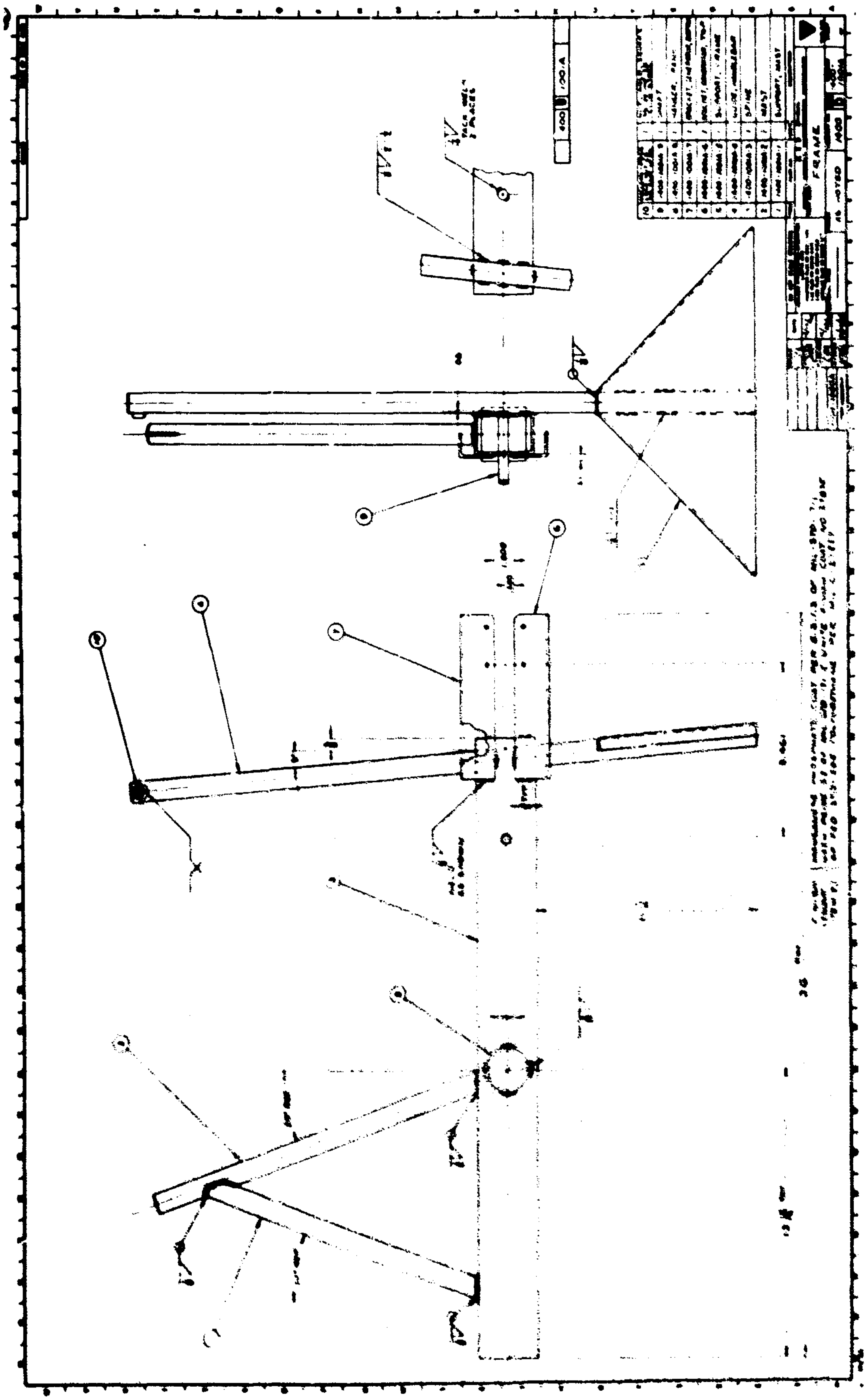
17. Varo, Inc., Santa Barbara, California, Quotation No. 076-387, dated October 4, 1966.

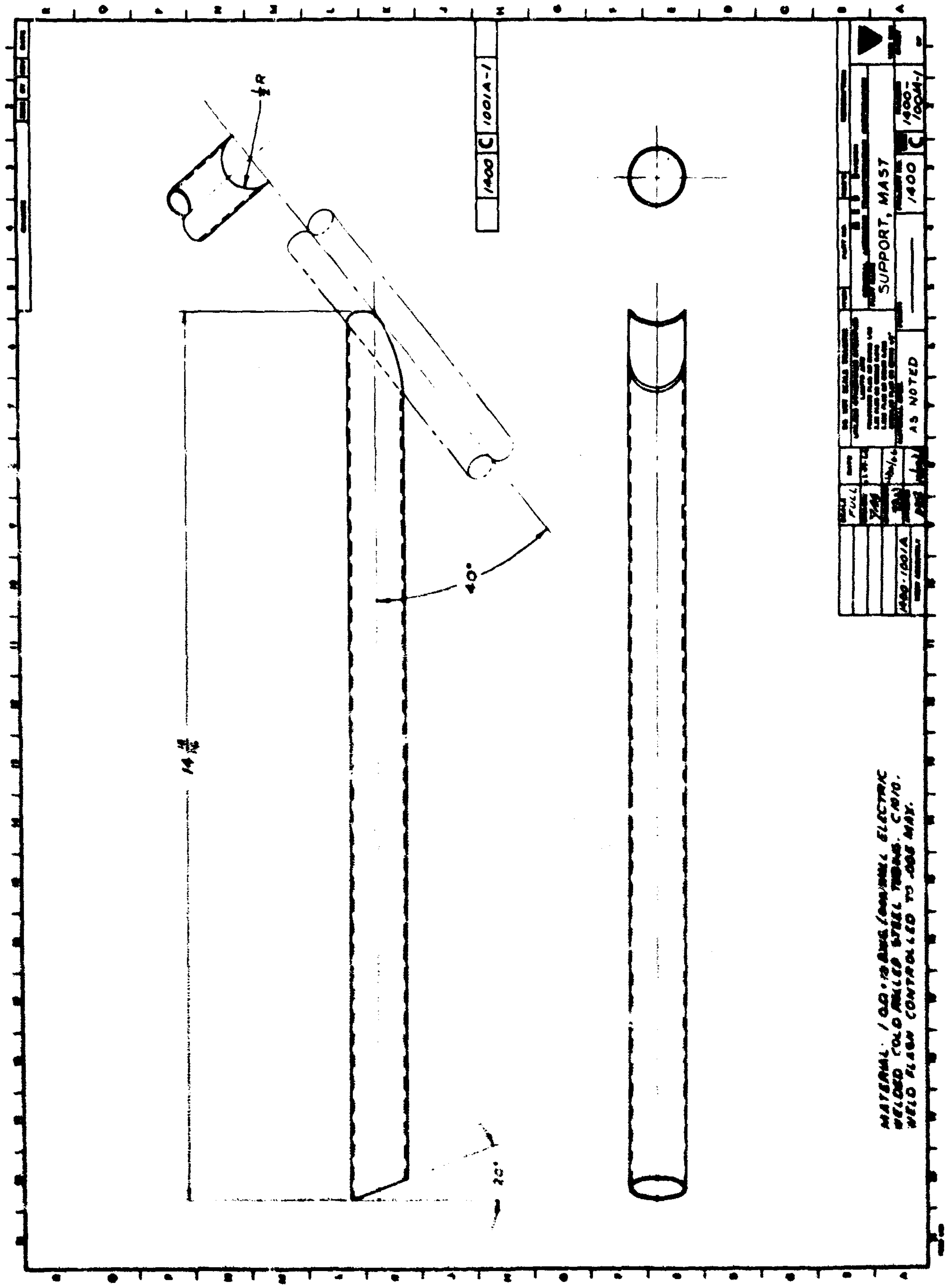
APPENDIX A

--DRAWINGS--

POWER UNIT WITH AN EXTERNAL ROLLER CHAIN TRANSMISSION







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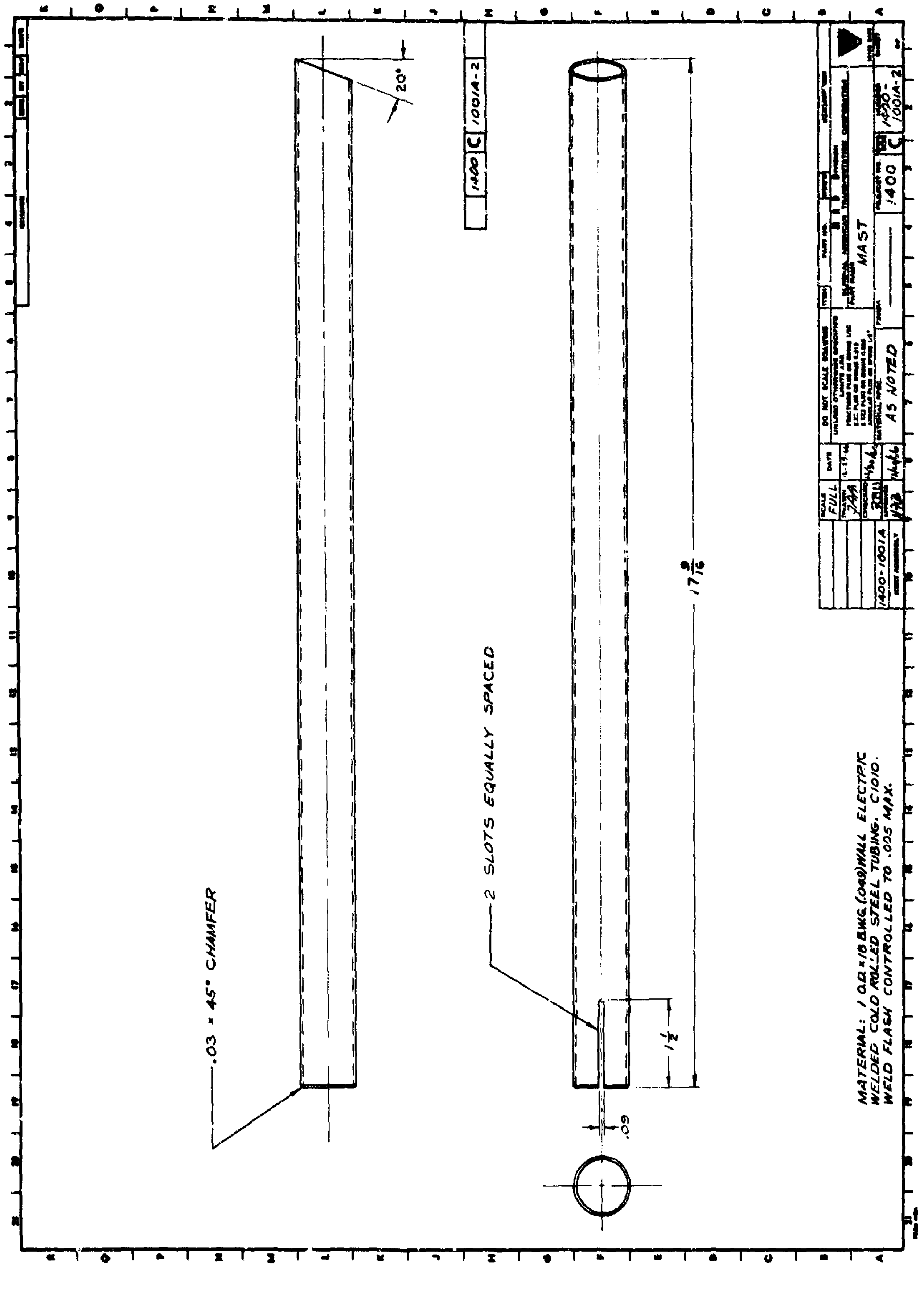
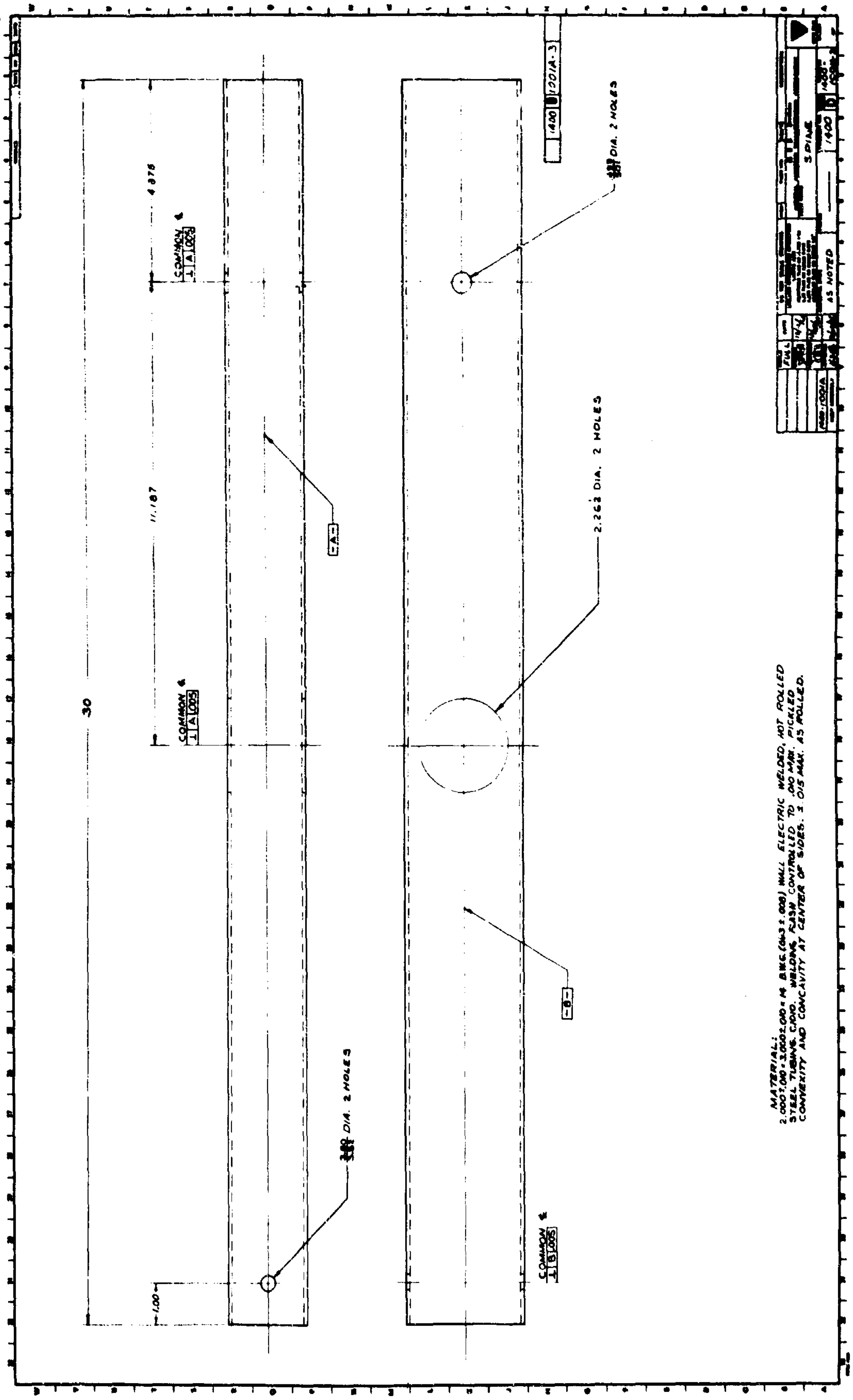
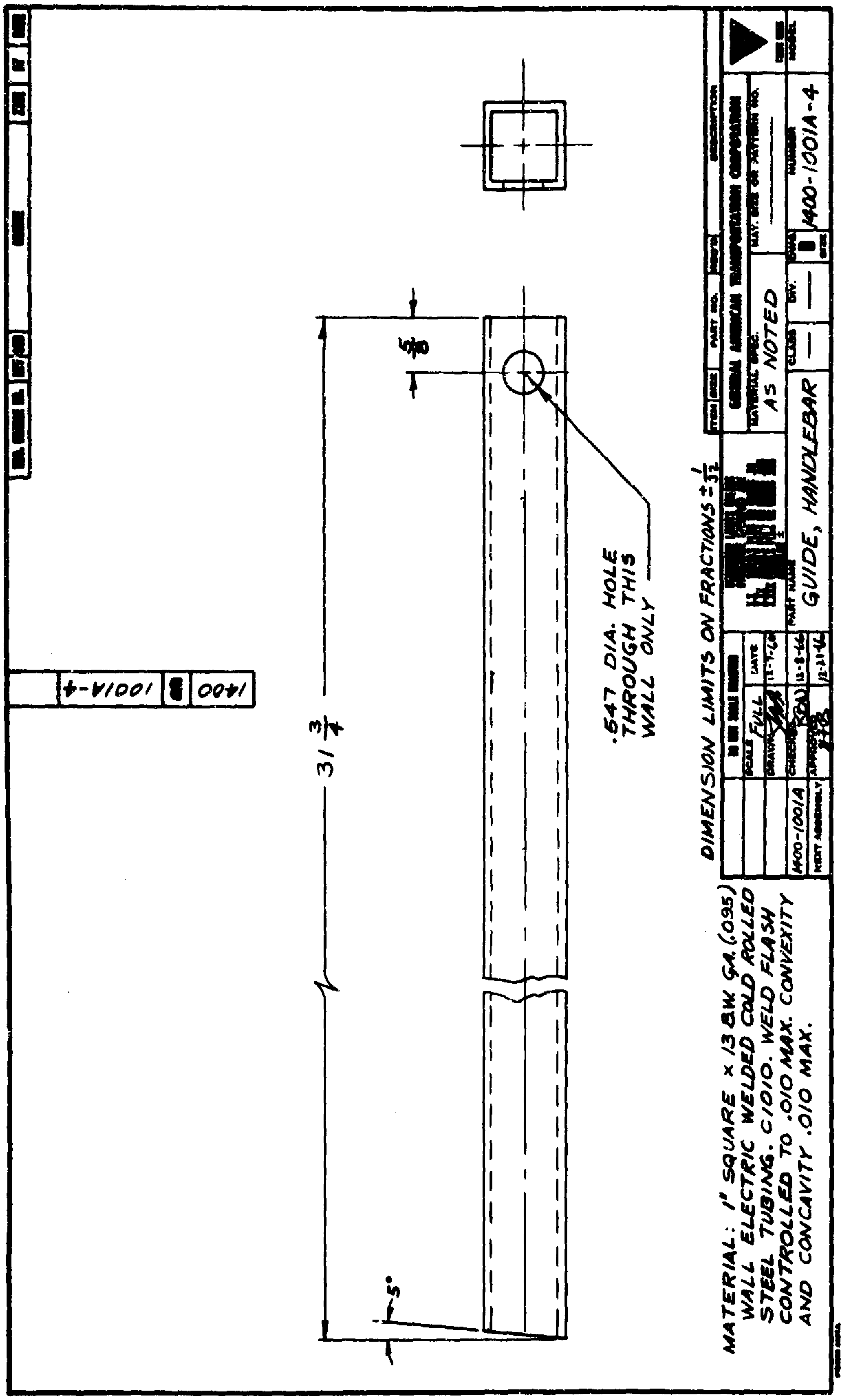
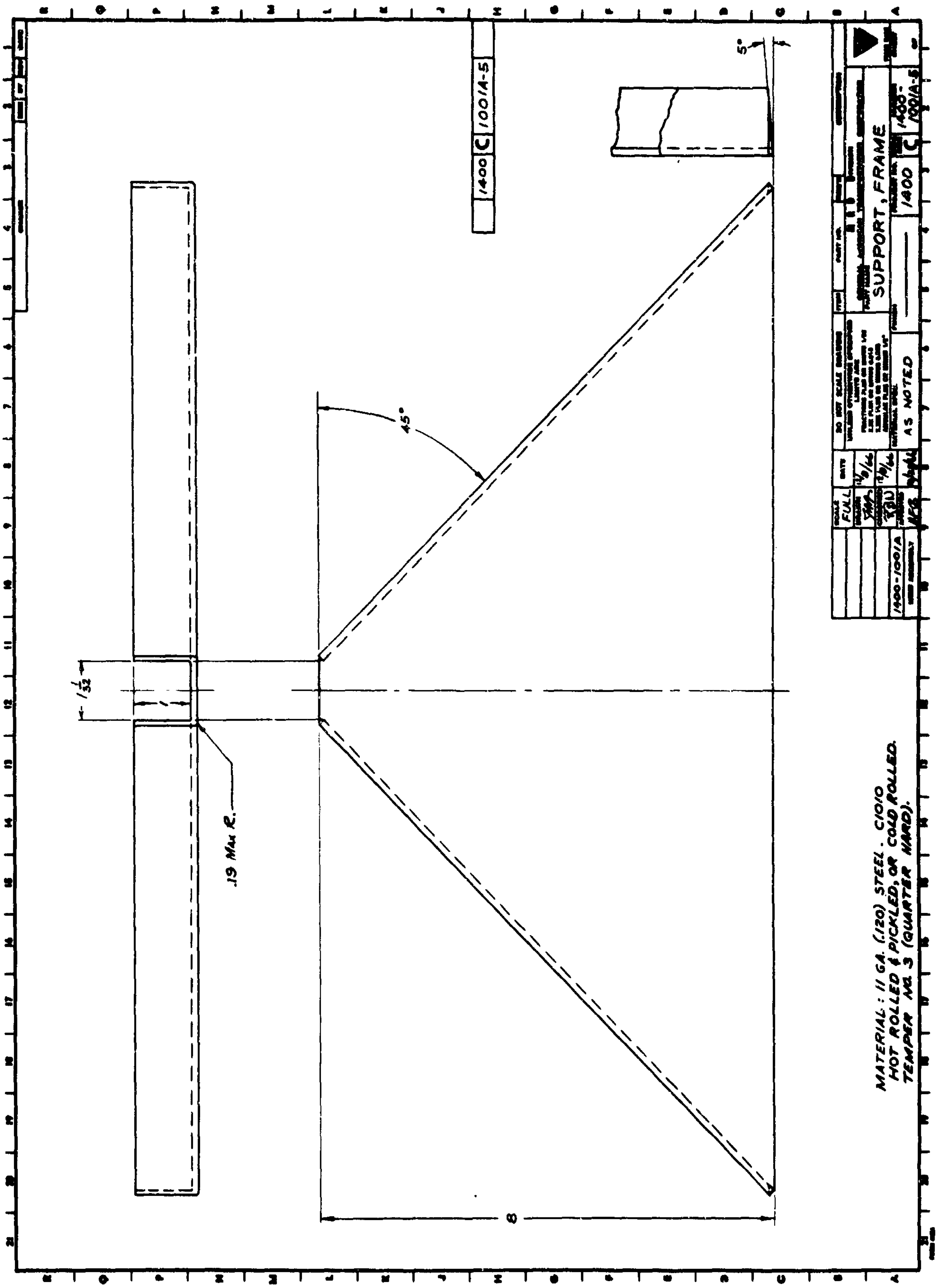

.03 × 45° CHAMFER
20°
1400 C 1001A-2
2 SLOTS EQUALLY SPACED
17 9/16
1/2
.09
MATERIAL: 1 O.D. × 18 B.W.G. (.049) WALL ELECTRIC
WELDED COLD ROLLED STEEL TUBING. C1010.
WELD FLASH CONTROLLED TO .025 MAX.
SCALE FULL
AS NOTED
MAST
1400
1001A-2
1400-1001A

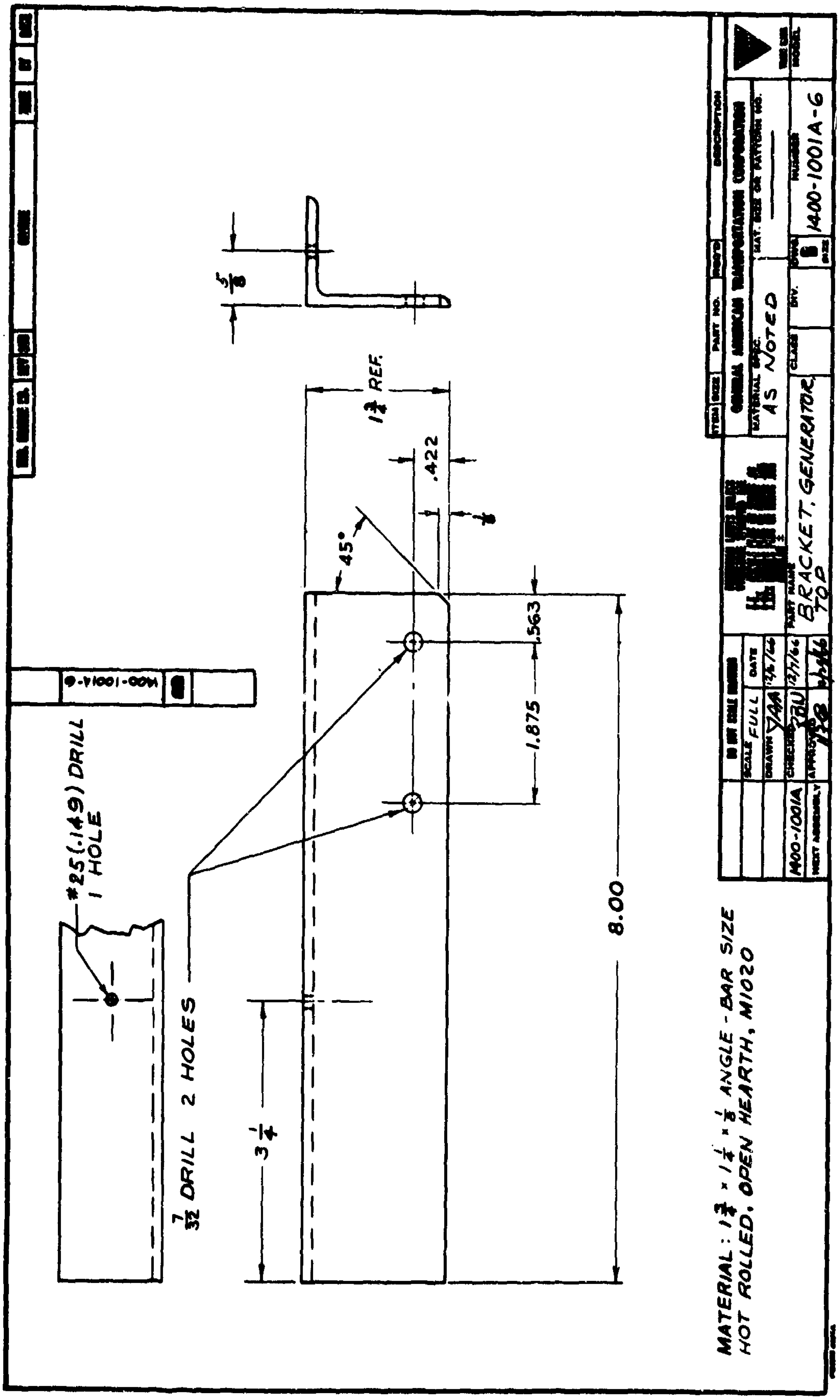


GENERAL AMERICAN RESEARCH DIVISION

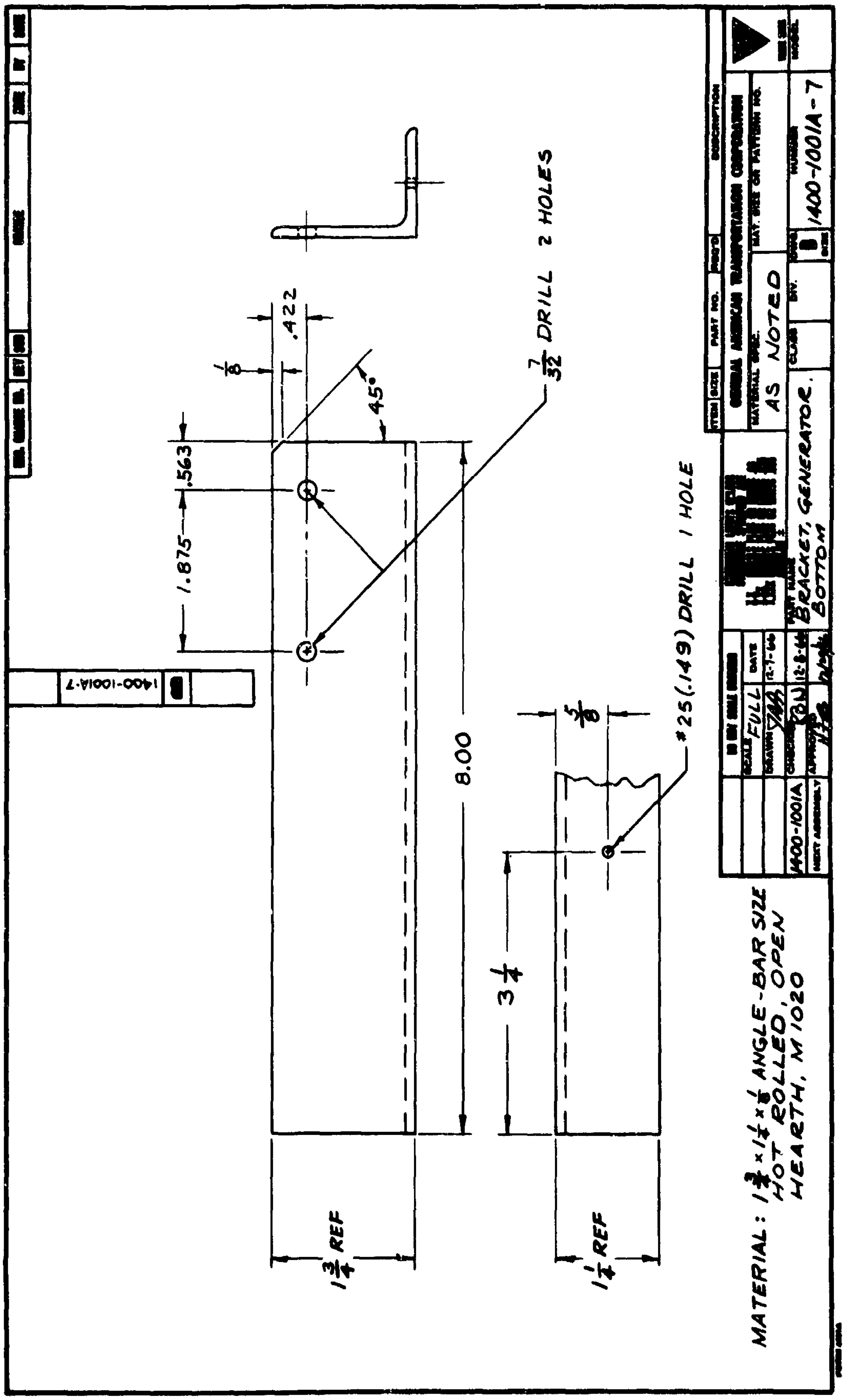


MATERIAL: 1" SQUARE x 13 B.W. GA. (.095) WALL ELECTRIC WELDED COLD ROLLED STEEL TUBING. C1010. WELD FLASH CONTROLLED TO .010 MAX. CONVEXITY AND CONCAVITY .010 MAX.
DIMENSION LIMITS ON FRACTIONS ± 1/32
.547 DIA. HOLE THROUGH THIS WALL ONLY
31 3/4
5/8
5°
1400
1001A-4
SCALE FULL
DRAWN
CHECKED
APPROVED
1400-1001A
NEXT ASSEMBLY
MATERIAL SPEC.
AS NOTED
PART NAME
GUIDE, HANDLEBAR
CLASS
DIV.
NUMBER
1400-1001A-4


1400 C 1001A-5
5°
45°
1/32
.19 MAX R.
8
SUPPORT, FRAME
1400 C 1400-1001A-5
FULL
AS NOTED
1400-1001A
MATERIAL: 11 GA. (.120) STEEL. C1010
HOT ROLLED & PICKLED, OR COLD ROLLED.
TEMPER NO. 3 (QUARTER HARD).

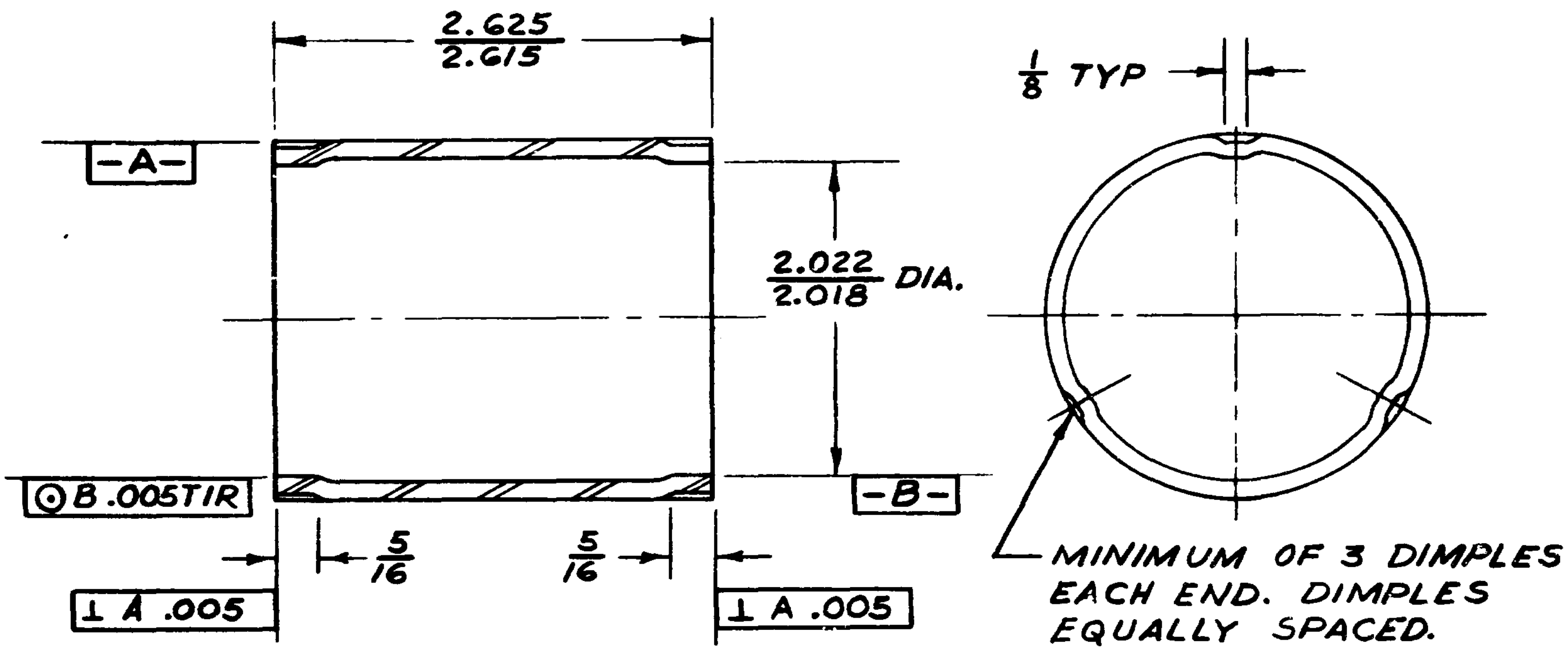


#25(.149) DRILL
1 HOLE
7/32 DRILL 2 HOLES
3 1/4
8.00
.563
1.875
45°
.422
1 1/4 REF.
5/8
MATERIAL: 1 1/4 x 1 1/4 x 1/8 ANGLE - BAR SIZE
HOT ROLLED, OPEN HEARTH, M1020
SCALE FULL
BRACKET, GENERATOR TOP
AS NOTED
GENERAL AMERICAN TRANSPORTATION CORPORATION
1400-1001A
1400-1001A-6



7/32 DRILL 2 HOLES
#25 (.149) DRILL 1 HOLE
.422
1/8
45°
.563
1.875
8.00
5/8
3 1/4
1 3/4 REF
1 1/4 REF
MATERIAL: 1 3/4 × 1 1/4 × 1/8 ANGLE-BAR SIZE HOT ROLLED, OPEN HEARTH, M1020
GENERAL AMERICAN TRANSPORTATION CORPORATION
AS NOTED
BRACKET, GENERATOR, BOTTOM
SCALE FULL
1400-1001A
1400-1001A-7

	A	1400-1001A-8	

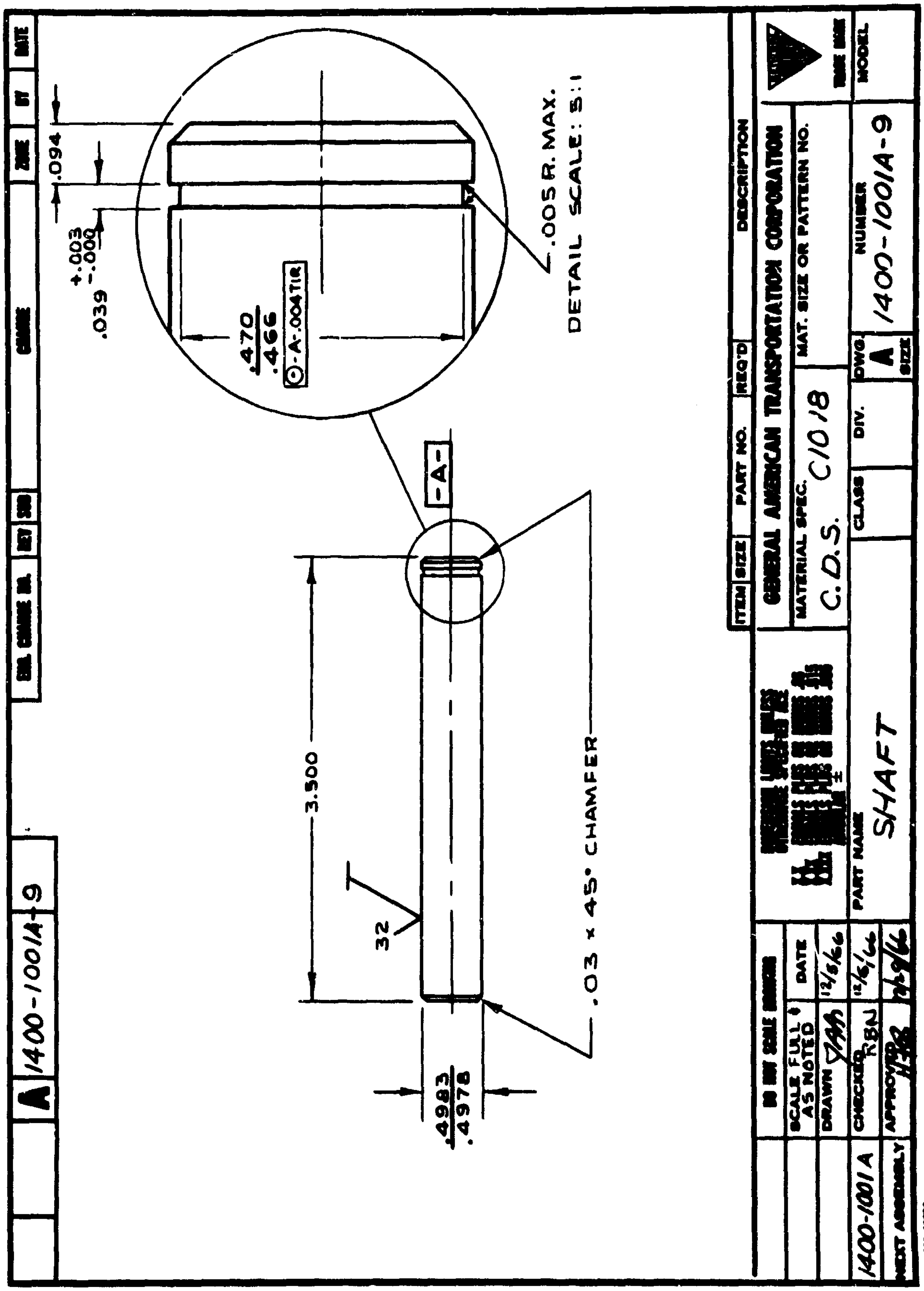


MATERIAL:
2.250 ±.006 O.D. × 12 B.W. GA. (.109 +.002, −.008) WALL
ELECTRIC WELDED HOT ROLLED STEEL TUBING. C1010. PICKLED.
WELD FLASH CONTROLLED TO .010 MAX.

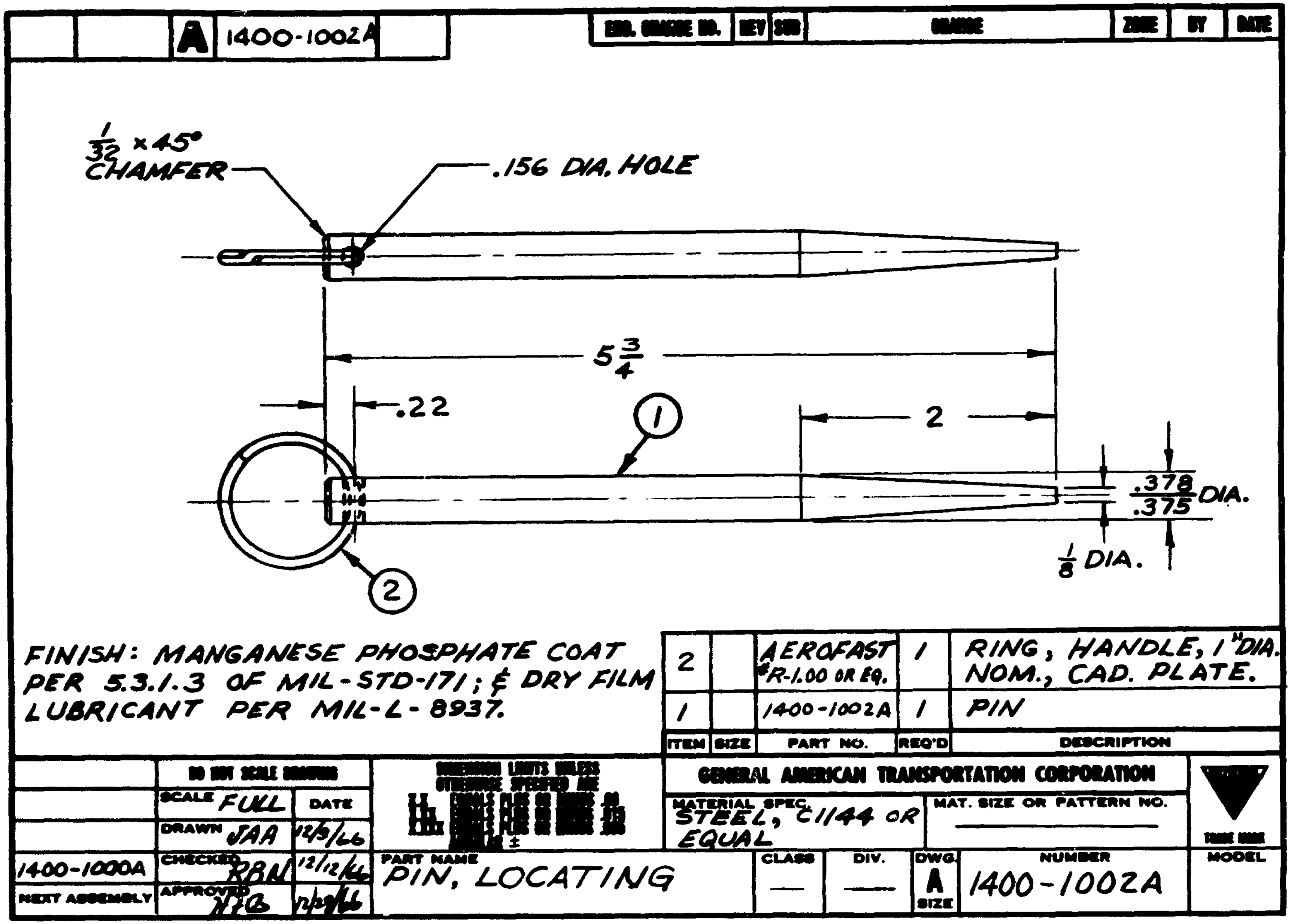
ITEM	SIZE	PART NO.	REQ'D	DESCRIPTION

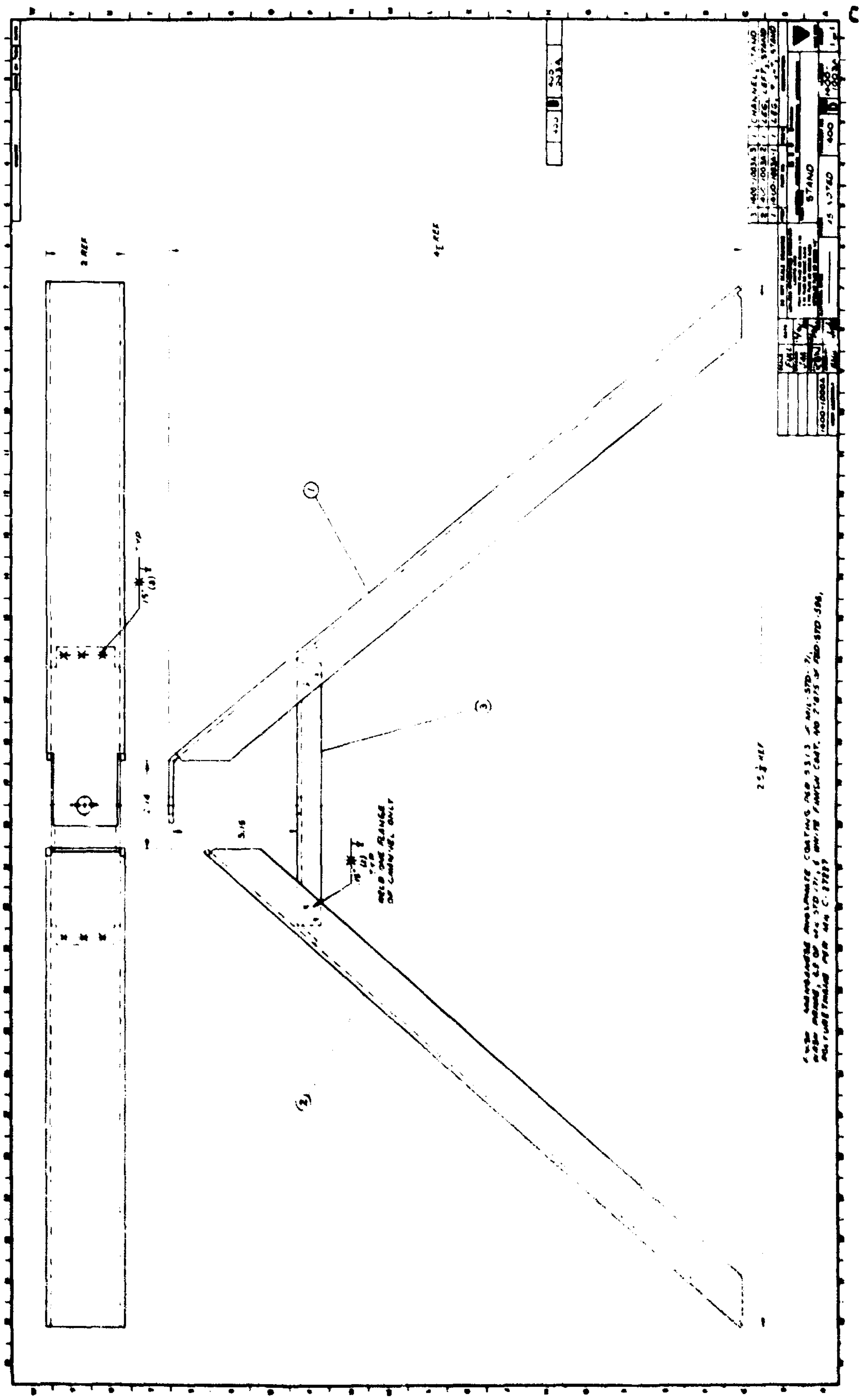
DO NOT SCALE DRAWING		GENERAL AMERICAN TRANSPORTATION CORPORATION
SCALE FULL	DATE	MATERIAL SPEC. SEE NOTE
DRAWN JAA	12/5/66	MAT. SIZE OR PATTERN NO.
CHECKED RBU	12/6/66	PART NAME HANGER, CRANK
APPROVED	12/19/66	CLASS / DIV. / DWG. SIZE A / NUMBER 1400-1001A-8 / MODEL
1400-1001A NEXT ASSEMBLY		

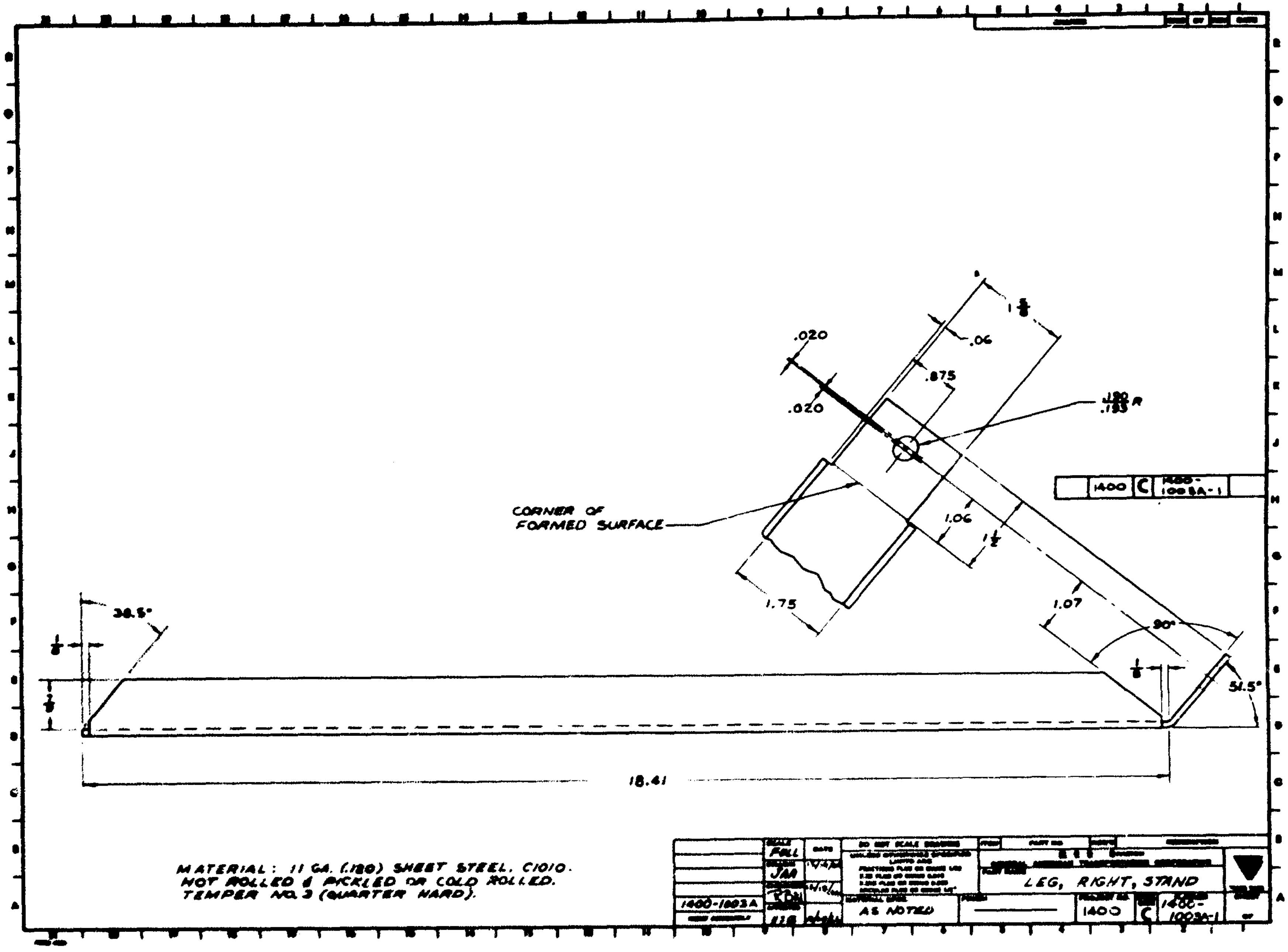
FORM 4008A

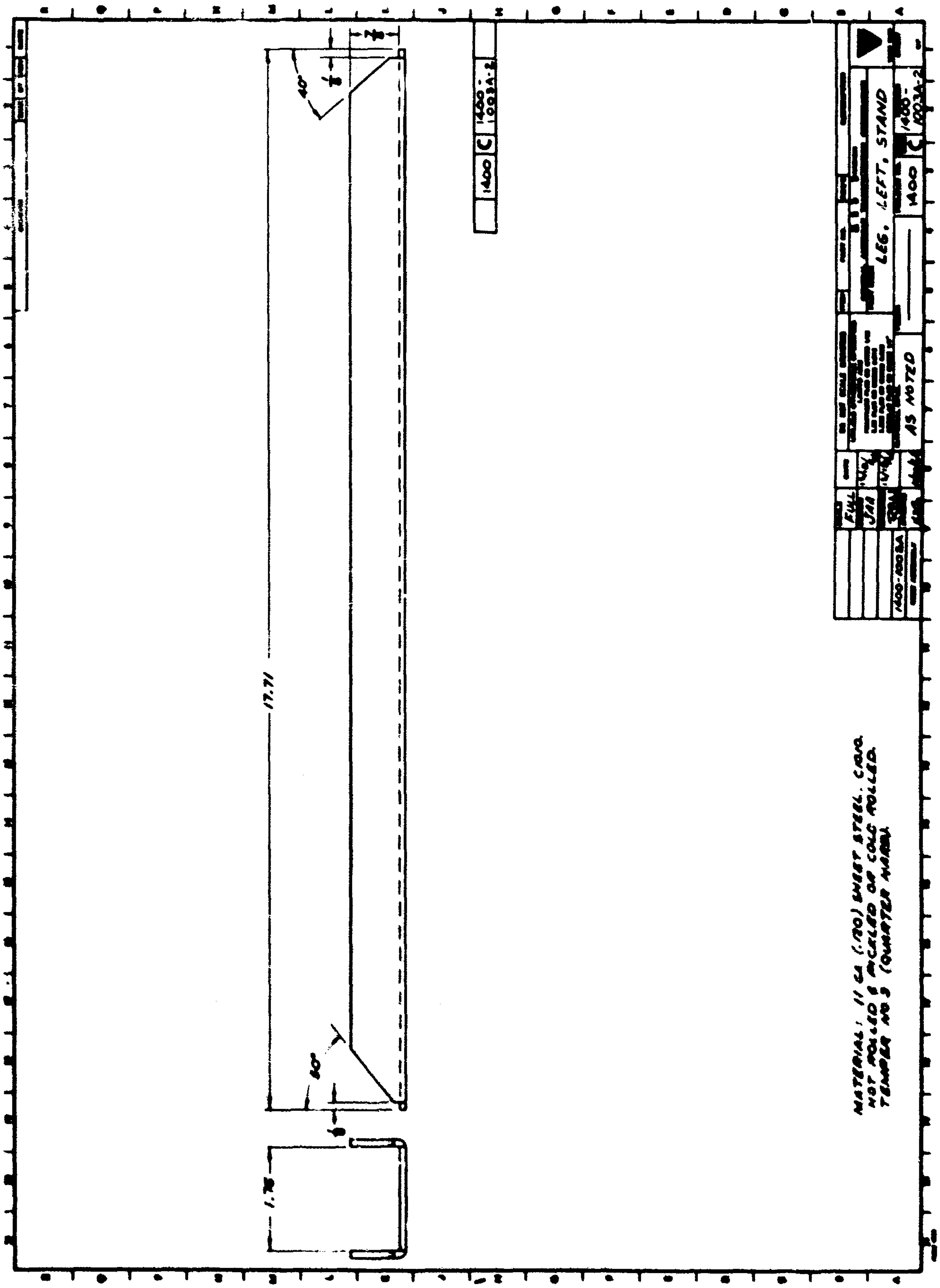


.094
+.003
-.000
.039
.470
.466
⊙-A-.004TIR
.005 R. MAX.
DETAIL SCALE: 5:1
-A-
3.500
32
.03 x 45° CHAMFER
.4983
.4978
A 1400-1001A 9
CHANGE
ZONE
BY
DATE
ITEM
SIZE
PART NO.
REQ'D
DESCRIPTION
GENERAL AMERICAN TRANSPORTATION CORPORATION
TRADE MARK
MATERIAL SPEC.
C.D.S. C1018
MAT. SIZE OR PATTERN NO.
MODEL
DO NOT SCALE DRAWING
SCALE FULL & AS NOTED
DATE
DRAWN 12/6/66
CHECKED RBN 12/6/66
APPROVED 12/9/66
NEXT ASSEMBLY 1400-1001A
PART NAME SHAFT
CLASS
DIV.
DWG SIZE A
NUMBER 1400-1001A-9

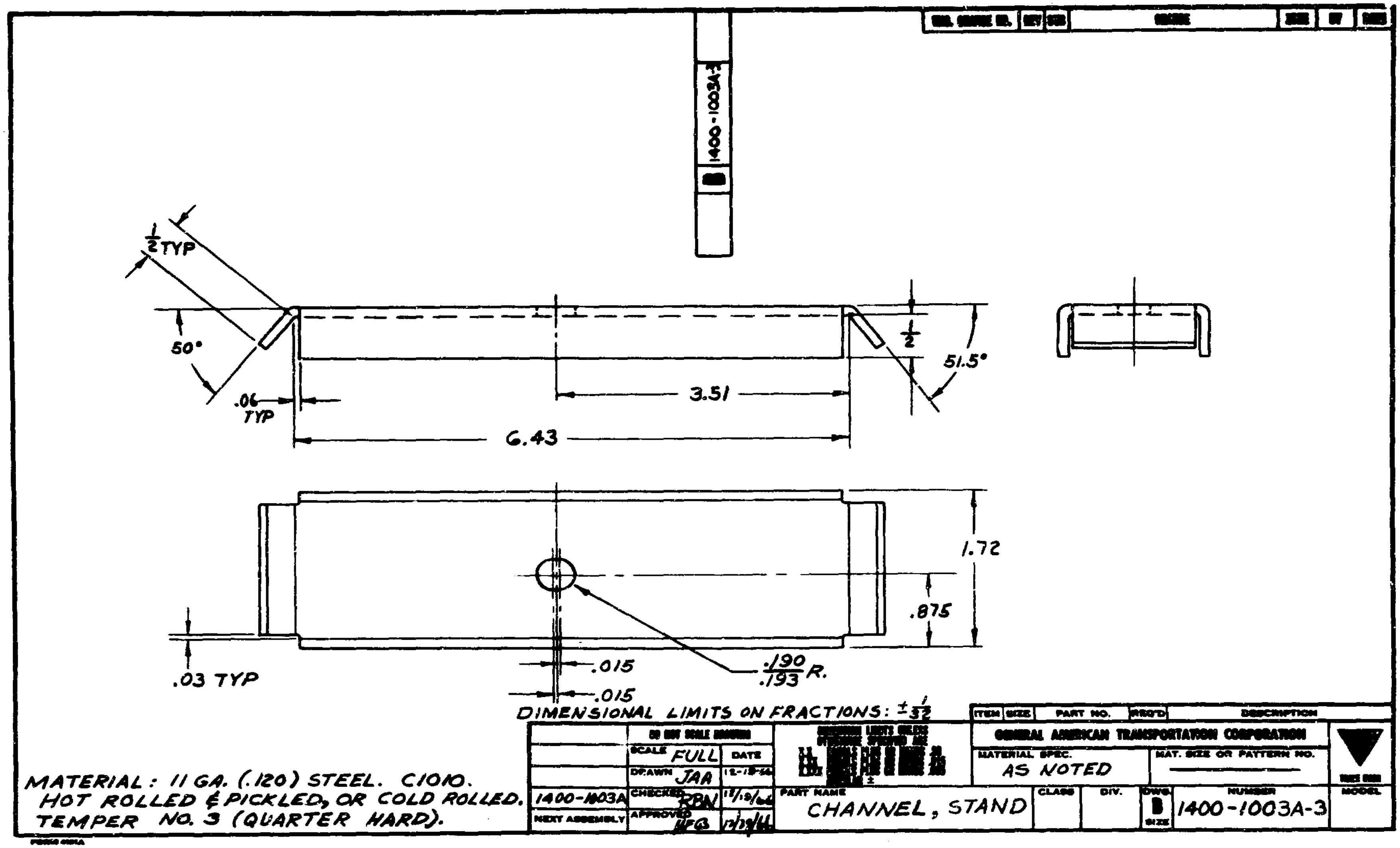

A 1400-1002A
ENG. CHANGE NO. | REV | SUB | CHANGE | ZONE | BY | DATE
1/32 x 45° CHAMFER
.156 DIA. HOLE
5 3/4
.22
2
1
2
.378/.375 DIA.
1/8 DIA.
FINISH: MANGANESE PHOSPHATE COAT PER 5.3.1.3 OF MIL-STD-171; & DRY FILM LUBRICANT PER MIL-L-8937.
2 | AEROFAST #R-1.00 OR EQ. | 1 | RING, HANDLE, 1" DIA. NOM., CAD. PLATE.
1 | 1400-1002A | 1 | PIN
ITEM | SIZE | PART NO. | REQ'D | DESCRIPTION
DO NOT SCALE DRAWING
SCALE FULL
DATE
DRAWN JAA 12/5/66
CHECKED RBN 12/12/66
APPROVED
DIMENSION LIMITS UNLESS OTHERWISE SPECIFIED ARE
GENERAL AMERICAN TRANSPORTATION CORPORATION
MATERIAL SPEC. STEEL, C1144 OR EQUAL
MAT. SIZE OR PATTERN NO.
TRADE MARK
MODEL
1400-1000A
NEXT ASSEMBLY
PART NAME PIN, LOCATING
CLASS —
DIV. —
DWG. A SIZE
NUMBER 1400-1002A



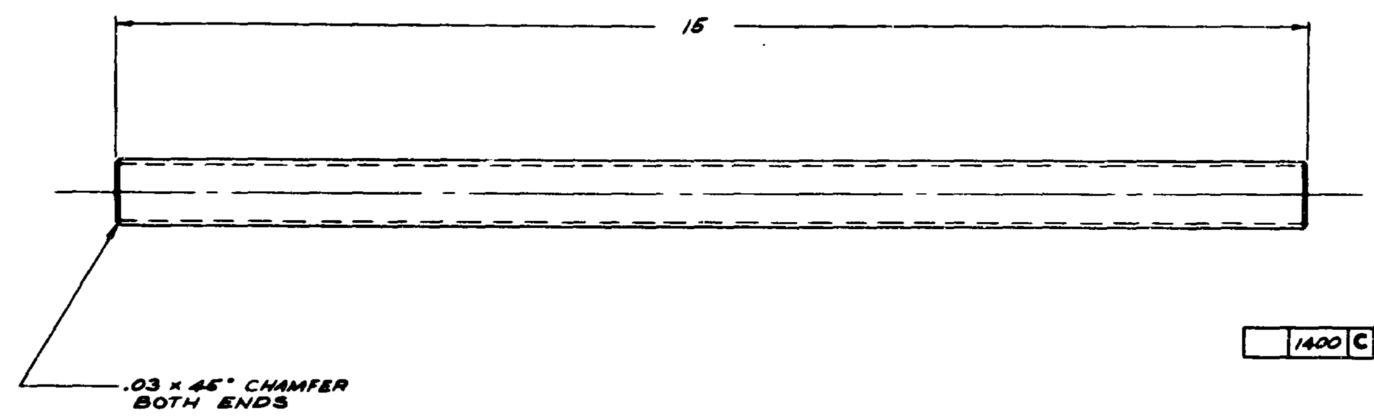

CORNER OF
FORMED SURFACE
.020
.020
.06
.875
1 5/8
.130/.133 R
1.06
1 1/2
1.75
1.07
90°
51.5°
38.5°
1/8
18.41
1400
C
1400-1003A-1
MATERIAL: 11 GA. (.120) SHEET STEEL, C1010.
HOT ROLLED & PICKLED OR COLD ROLLED.
TEMPER NO. 3 (QUARTER HARD).
FULL
JAA
AS NOTED
LEG, RIGHT, STAND
1400-1003A



GENERAL AMERICAN RESEARCH DIVISION



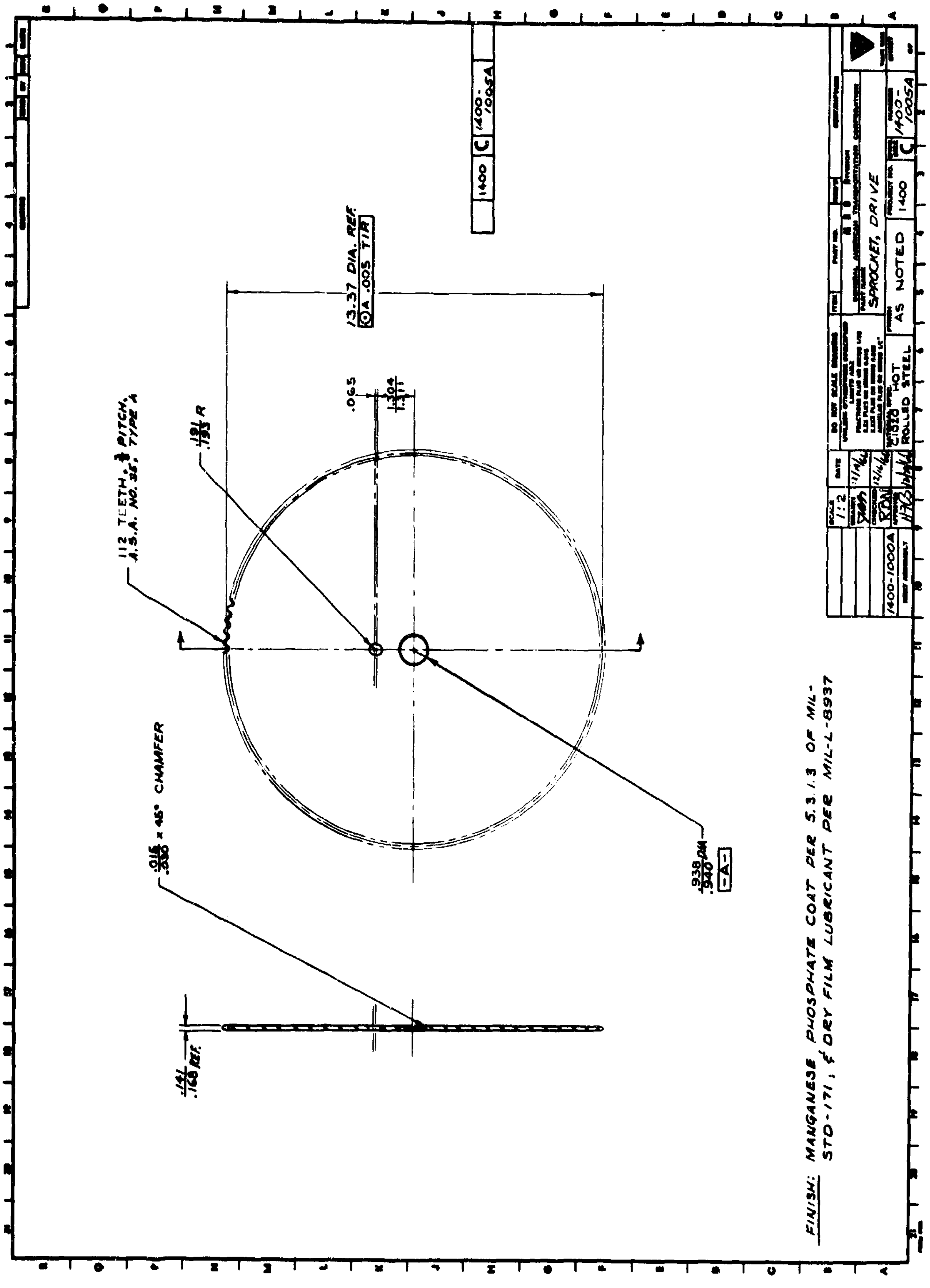
1400-1003A-3
1/2 TYP
50°
.06 TYP
3.51
6.43
1/2
51.5°
1.72
.875
.03 TYP
.015
.015
.190/.193 R.
DIMENSIONAL LIMITS ON FRACTIONS: ±1/32
MATERIAL: 11 GA. (.120) STEEL. C1010.
HOT ROLLED & PICKLED, OR COLD ROLLED.
TEMPER NO. 3 (QUARTER HARD).
ITEM
SIZE
PART NO.
REQ'D
DESCRIPTION
GENERAL AMERICAN TRANSPORTATION CORPORATION
MATERIAL SPEC.
AS NOTED
MAT. SIZE OR PATTERN NO.
SCALE FULL
DATE
DRAWN JAA
CHECKED RBN
APPROVED
1400-1003A
NEXT ASSEMBLY
PART NAME
CHANNEL, STAND
CLASS
DIV.
DWG. SIZE B
NUMBER
1400-1003A-3
MODEL

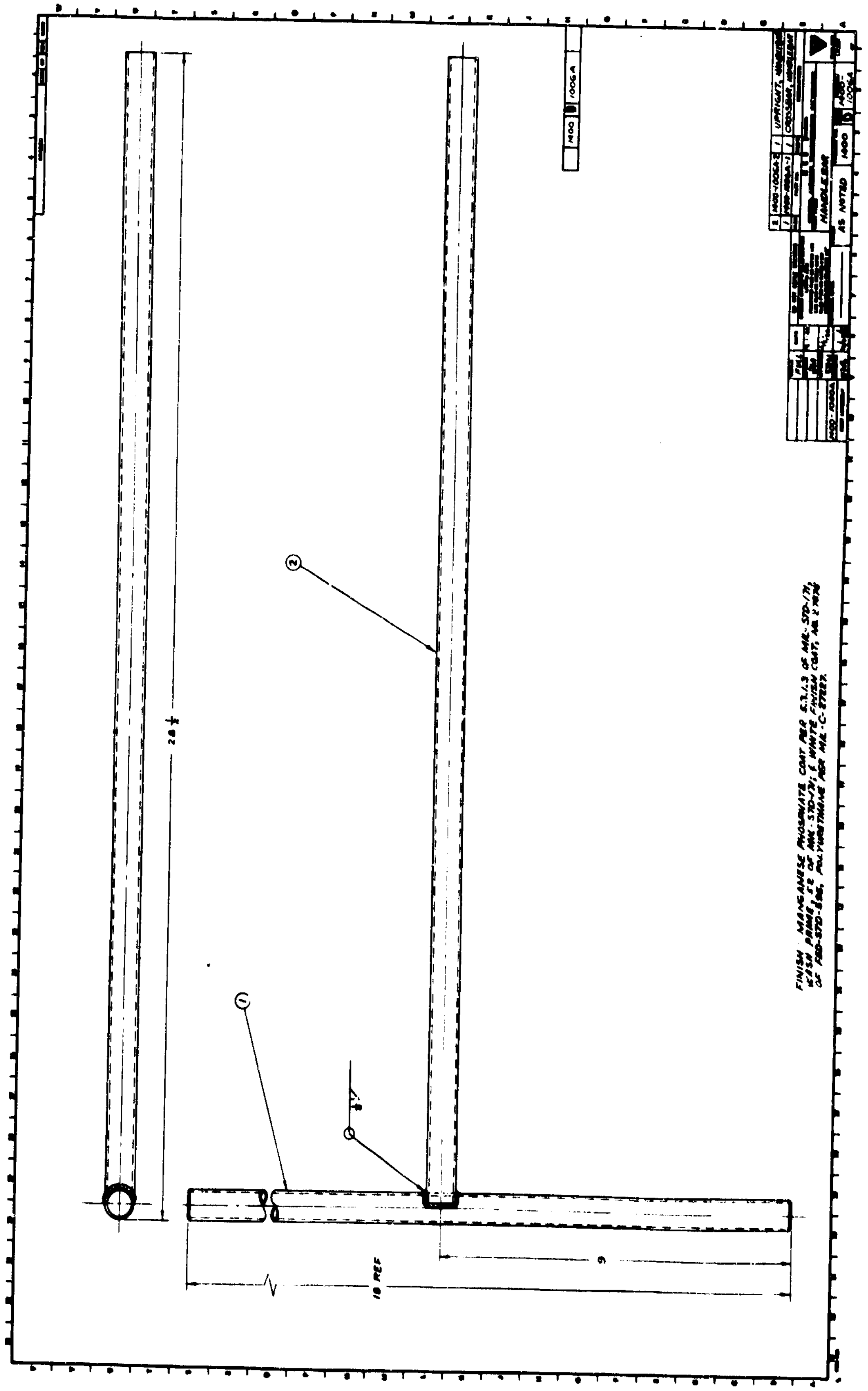


MATERIAL: .875 ± .004 O.D. × 16 B.W. GA. (.065) WALL ELECTRIC WELDED COLD ROLLED STEEL TUBING. C1010.

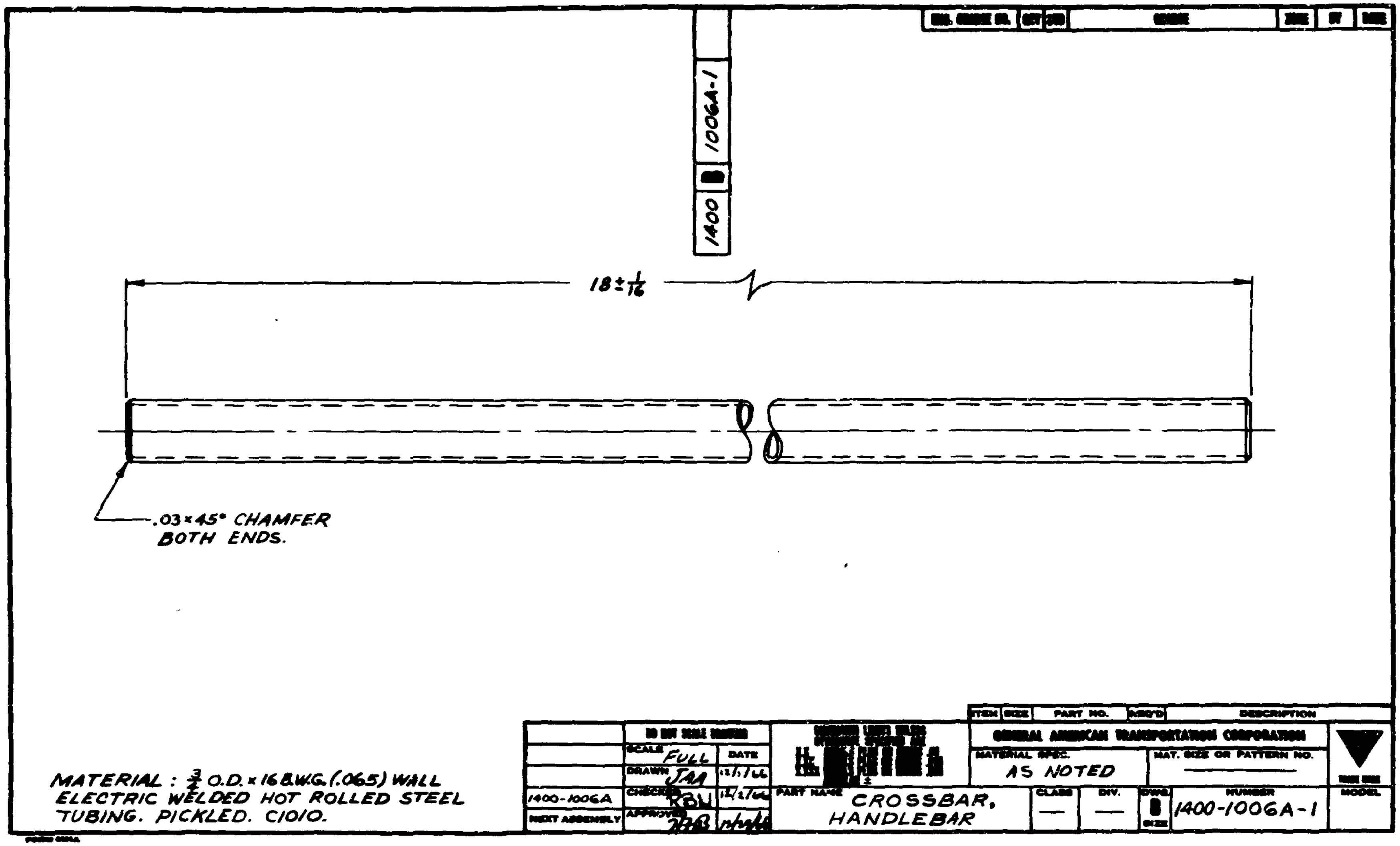
FINISH: MANGANESE PHOSPHATE COAT PER 5.3.1.3 OF MIL-STD-171, AND DRY FILM LUBRICANT PER MIL-L-8937.

SCALE	FULL
NEXT ASSEMBLY	1400-1000A
MATERIAL SPEC.	AS NOTED
FINISH	AS NOTED
PART NAME	POST, SADDLE
PROJECT NO.	1400
SIZE	C
NUMBER	1400-1004A

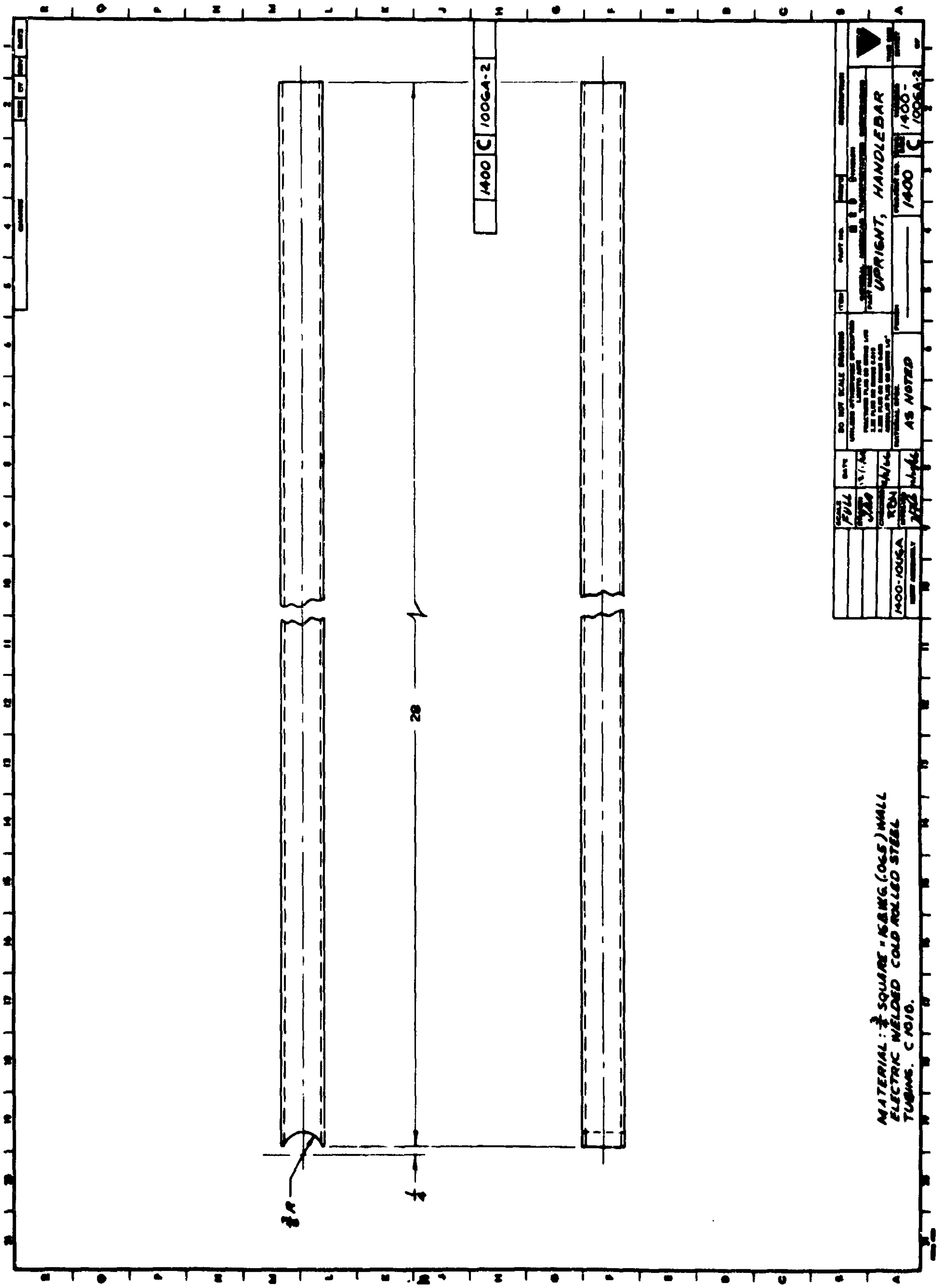

112 TEETH, ⅜ PITCH, A.S.A. NO. 35, TYPE A
.191
.193 R
.065
1.304
1.311
13.37 DIA. REF.
A .005 TIR
.938
.940 DIA
-A-
.015
.030 x 45° CHAMFER
.141
.168 REF.
FINISH: MANGANESE PHOSPHATE COAT PER 5.3.1.3 OF MIL-STD-171, & DRY FILM LUBRICANT PER MIL-L-8937
1400 C 1400-1005A
SPROCKET, DRIVE
SCALE 1:2
AS NOTED
1400
1400-1005A
C1020 HOT ROLLED STEEL
1400-1000A

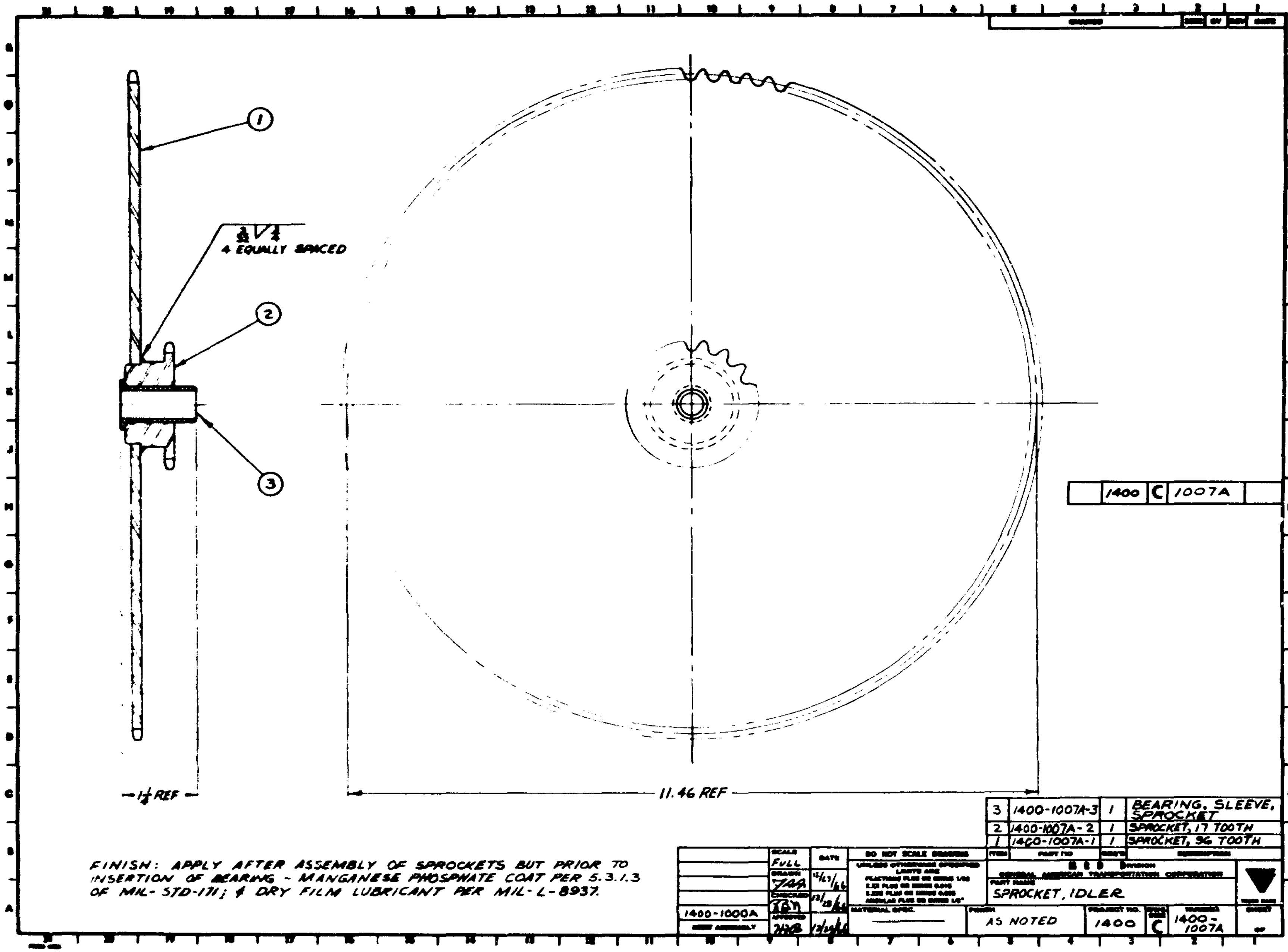


GENERAL AMERICAN RESEARCH DIVISION

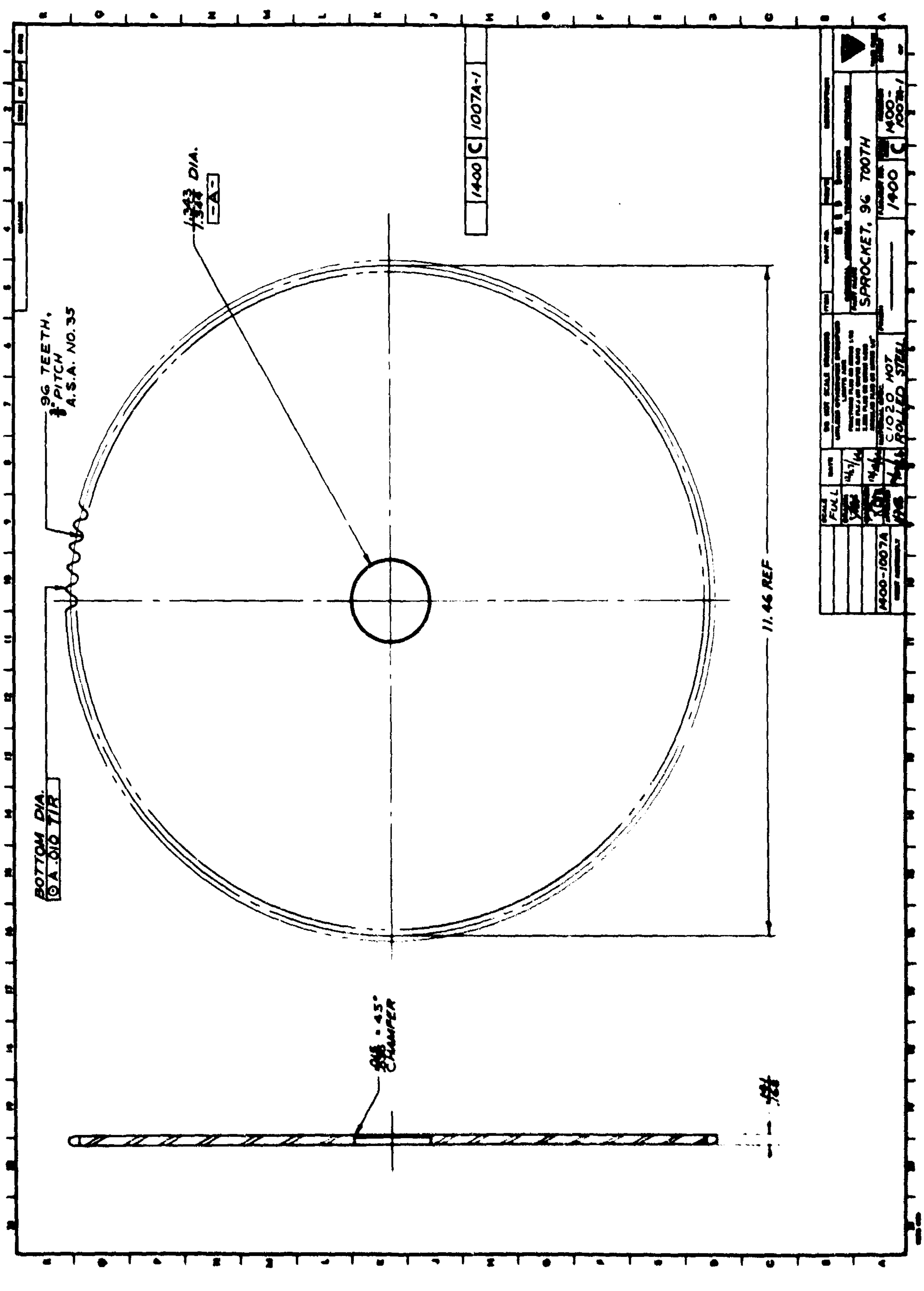


GENERAL AMERICAN RESEARCH DIVISION


1400 C 100GA-2
UPRIGHT, HANDLEBAR
AS NOTED
FULL
1400-100GA
28
MATERIAL: 3/4 SQUARE - 16 B.W.G. (.065) WALL ELECTRIC WELDED COLD ROLLED STEEL TUBING. C 1010.

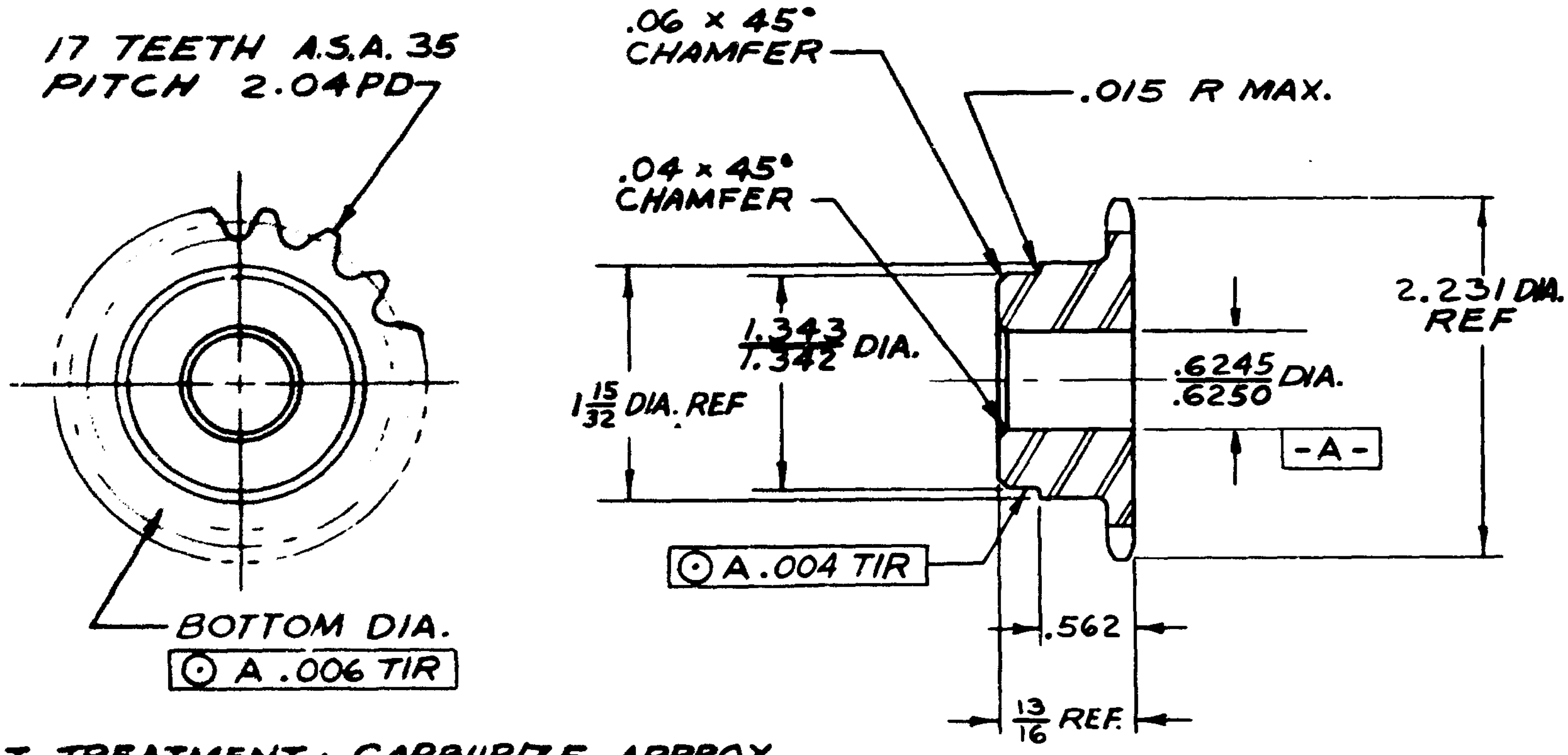


1
2
3
4 EQUALLY SPACED
1½ REF
11.46 REF
1400 C 1007A
FINISH: APPLY AFTER ASSEMBLY OF SPROCKETS BUT PRIOR TO INSERTION OF BEARING - MANGANESE PHOSPHATE COAT PER 5.3.1.3 OF MIL-STD-171; & DRY FILM LUBRICANT PER MIL-L-8937.
3 1400-1007A-3 1 BEARING, SLEEVE, SPROCKET
2 1400-1007A-2 1 SPROCKET, 17 TOOTH
1 1400-1007A-1 1 SPROCKET, 96 TOOTH
DO NOT SCALE DRAWING
GENERAL AMERICAN TRANSPORTATION CORPORATION
SCALE FULL
SPROCKET, IDLER
1400-1000A
AS NOTED
1400 C 1400-1007A



GENERAL AMERICAN RESEARCH DIVISION

1400 A 1007A-2

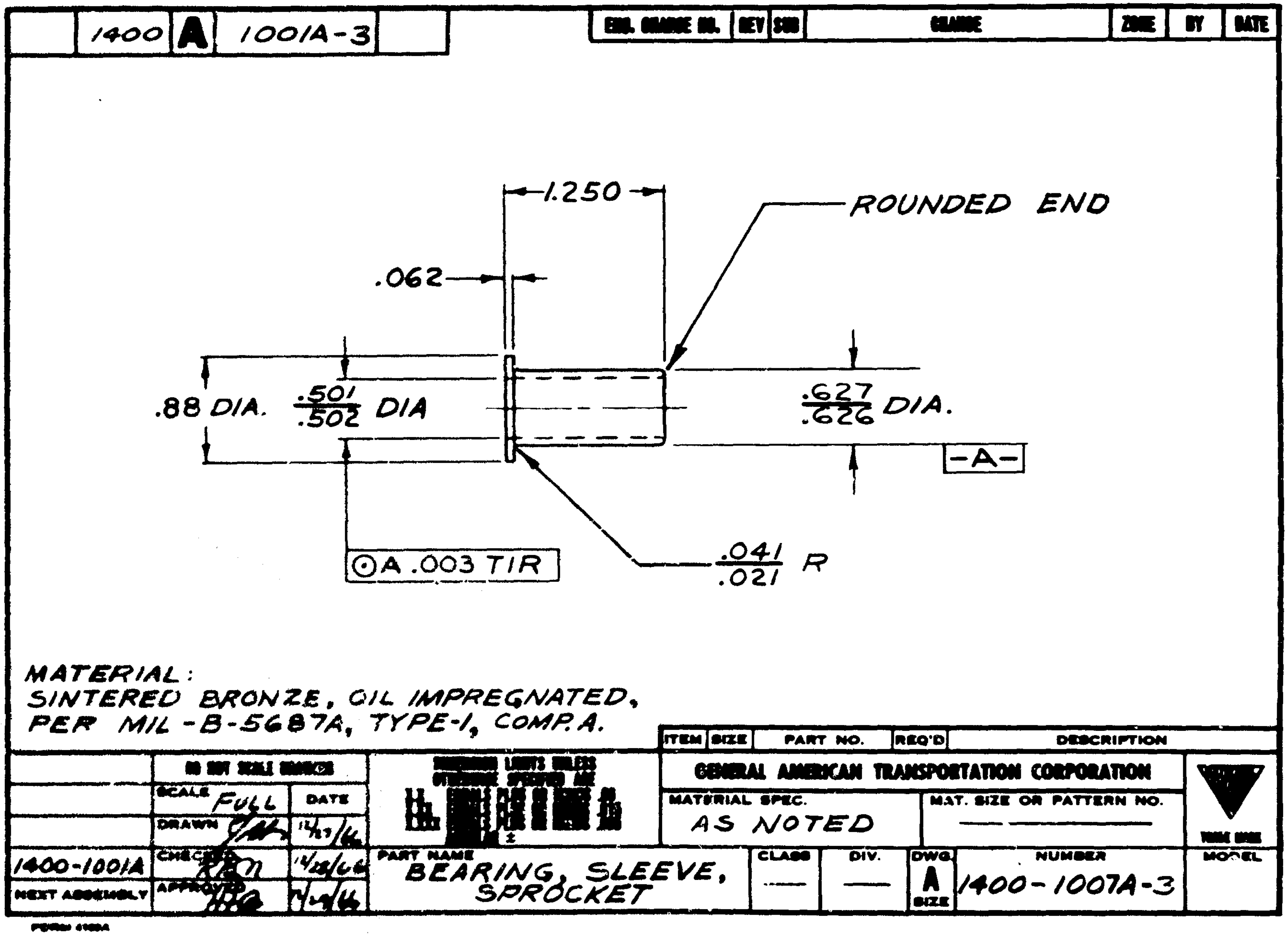


HEAT TREATMENT: CARBURIZE APPROX. .015 DEEP, INDUCTION HARDEN TEETH ONLY, AND TEMPER TO ROCKWELL C40-45

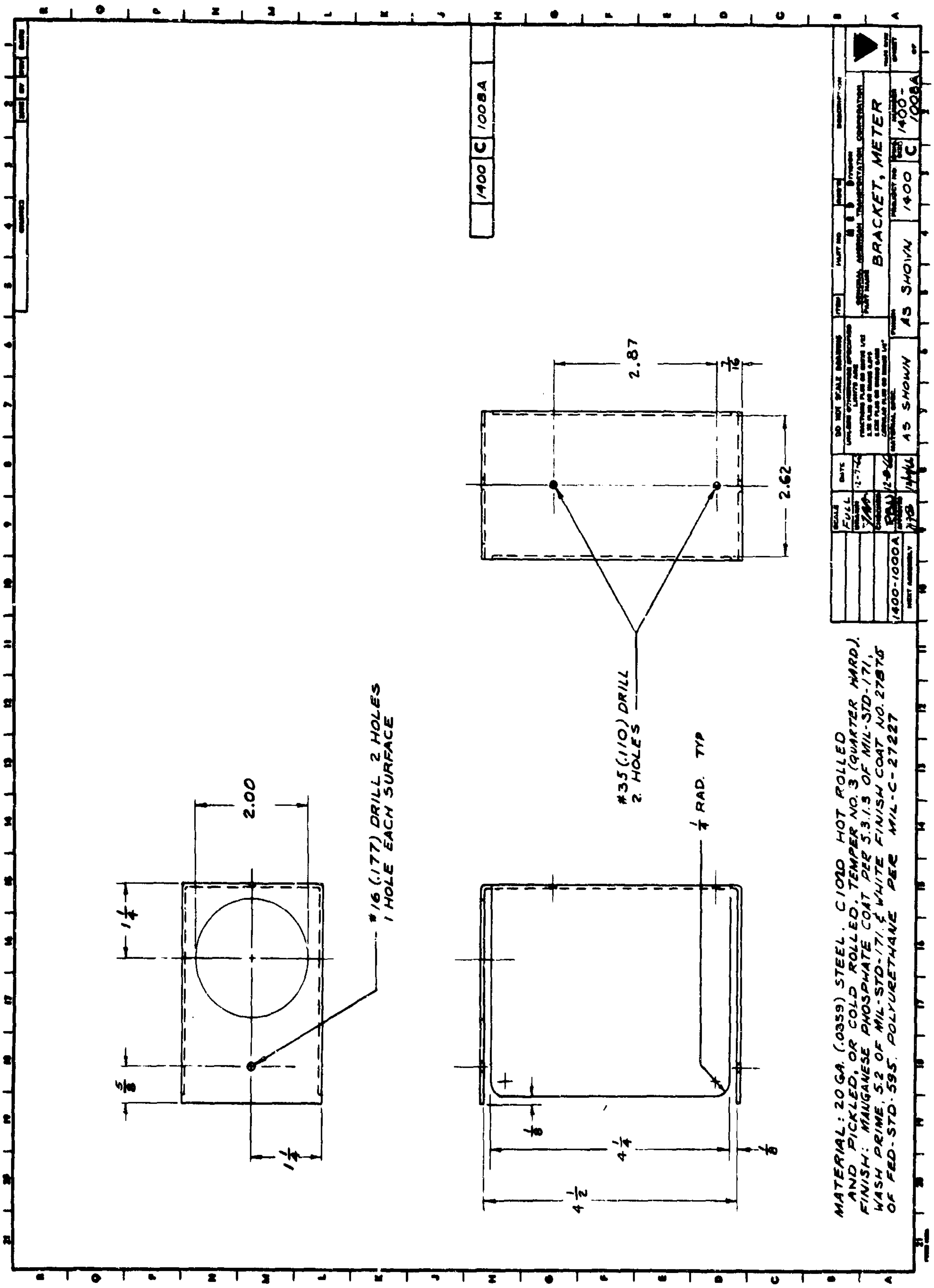
ITEM	SIZE	PART NO.	REQ'D	DESCRIPTION

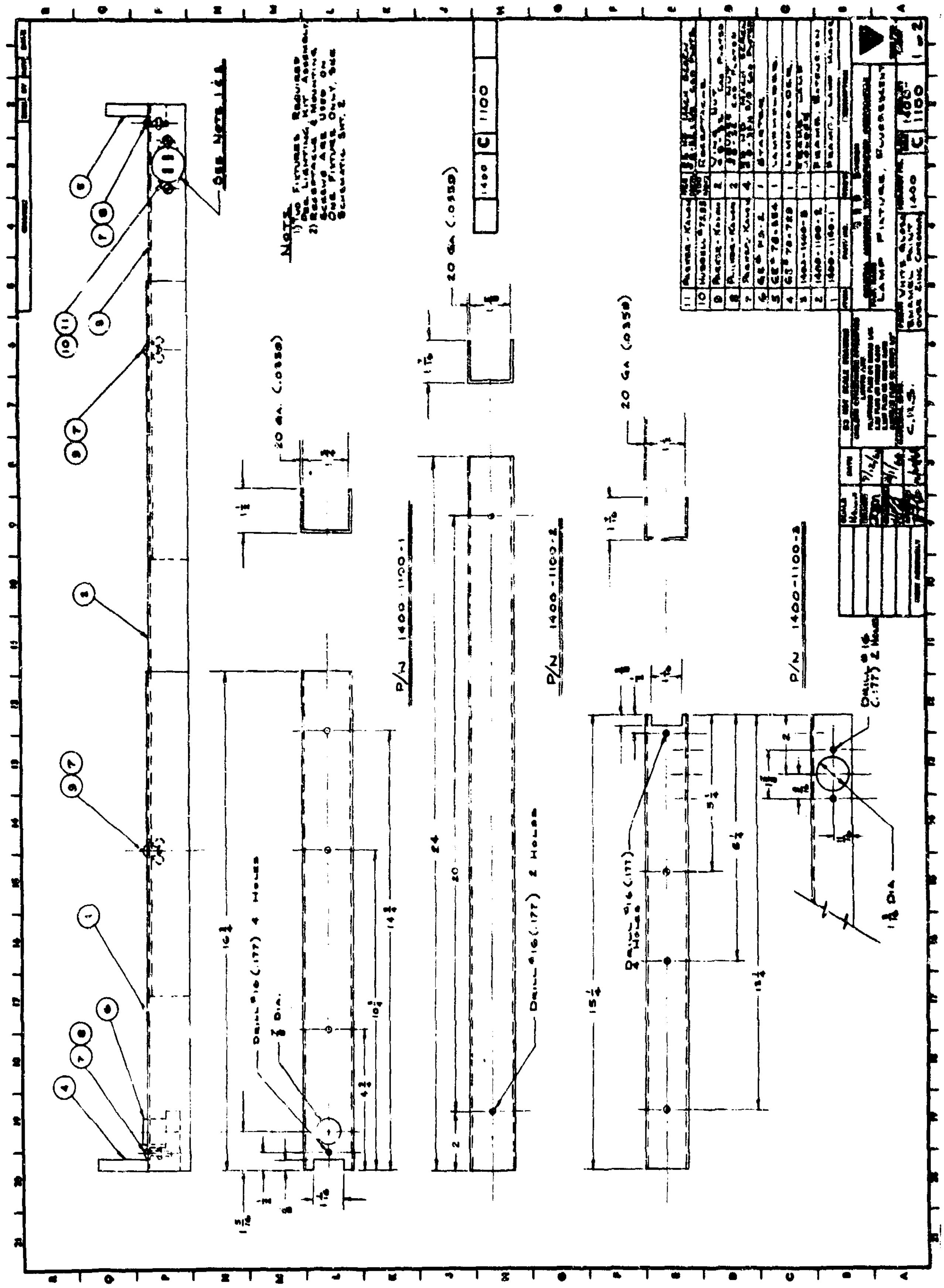
GENERAL AMERICAN TRANSPORTATION CORPORATION

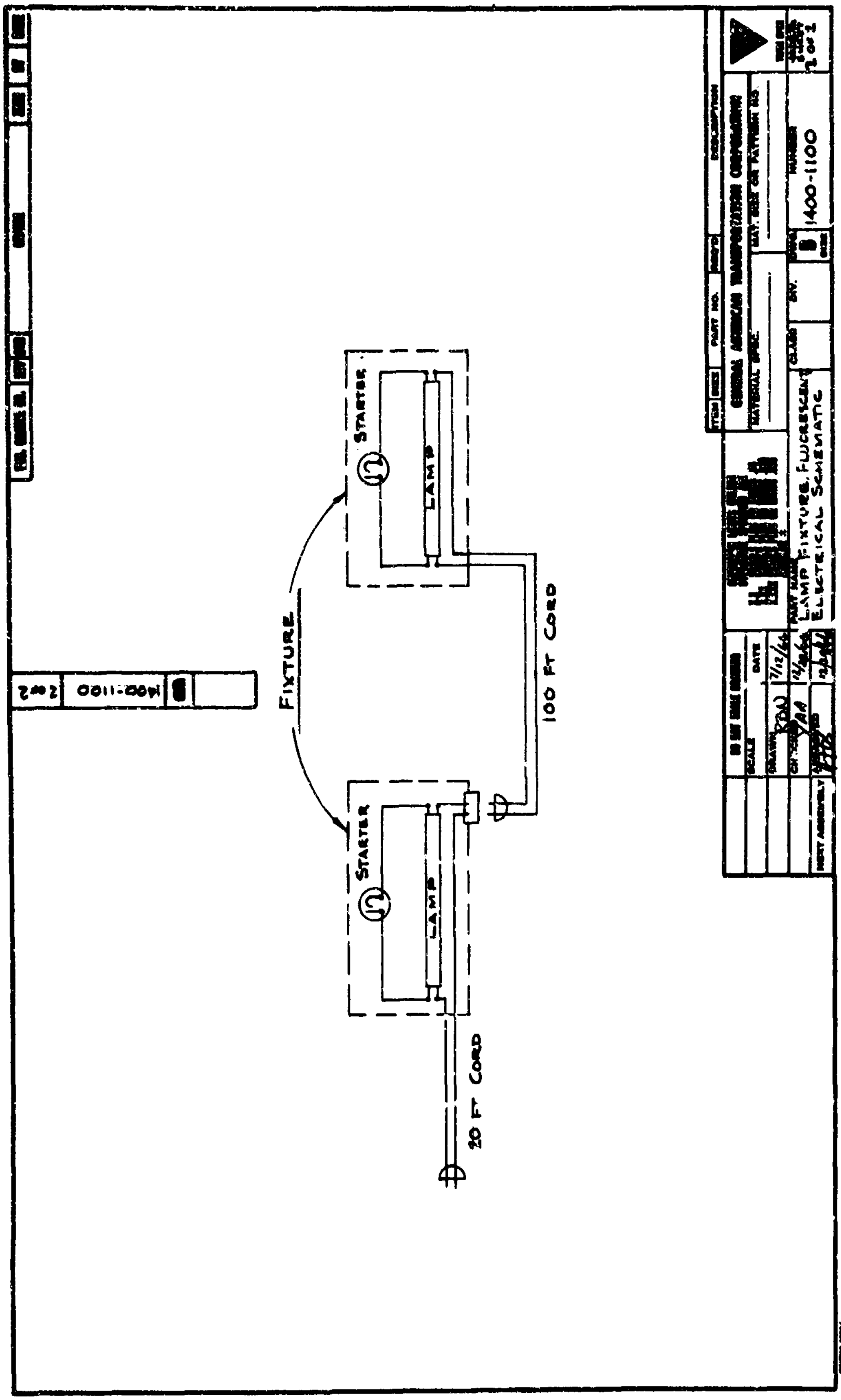
SCALE	FULL
DRAWN	12/21/66
CHECKED	12/28/66
APPROVED	
NEXT ASSEMBLY	1400-1007A
MATERIAL SPEC.	B1113 STEEL
MAT. SIZE OR PATTERN NO.	—
PART NAME	SPROCKET, 17 TOOTH
CLASS	—
DIV.	—
DWG. SIZE	A
NUMBER	1400-1007A-2



GENERAL AMERICAN RESEARCH DIVISION


1400 C 1008A
#16 (.177) DRILL 2 HOLES 1 HOLE EACH SURFACE
2.00
1 1/4
5/8
#35 (.110) DRILL 2 HOLES
1/4 RAD. TYP
2.87
7/16
2.62
1/8
4 1/4
4 1/2
MATERIAL: 20 GA. (.0359) STEEL. C1020 HOT ROLLED AND PICKLED, OR COLD ROLLED, TEMPER NO. 3 (QUARTER HARD).
FINISH: MANGANESE PHOSPHATE COAT PER 5.3.1.3 OF MIL-STD-171, WASH PRIME 5.2 OF MIL-STD-171 & WHITE FINISH COAT NO. 27875 OF FED-STD-595. POLYURETHANE PER MIL-C-27227
BRACKET, METER
FULL
AS SHOWN
AS SHOWN
1400-1000A
1400
C
1400-1008A

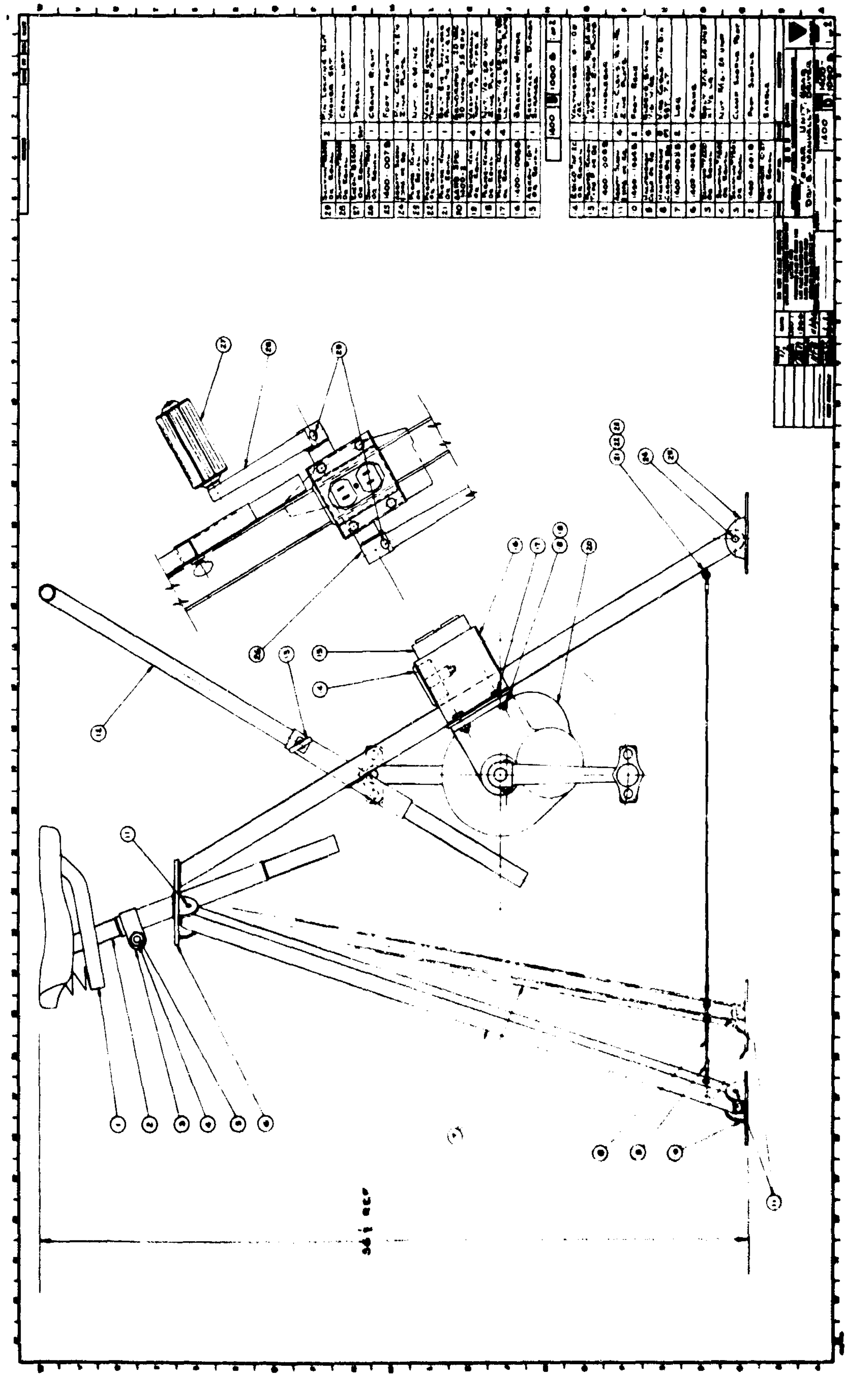

P/N 1400-1100-1
P/N 1400-1100-2
P/N 1400-1100-3
20 GA (.0359)
LAMP FIXTURE, FLUORESCENT

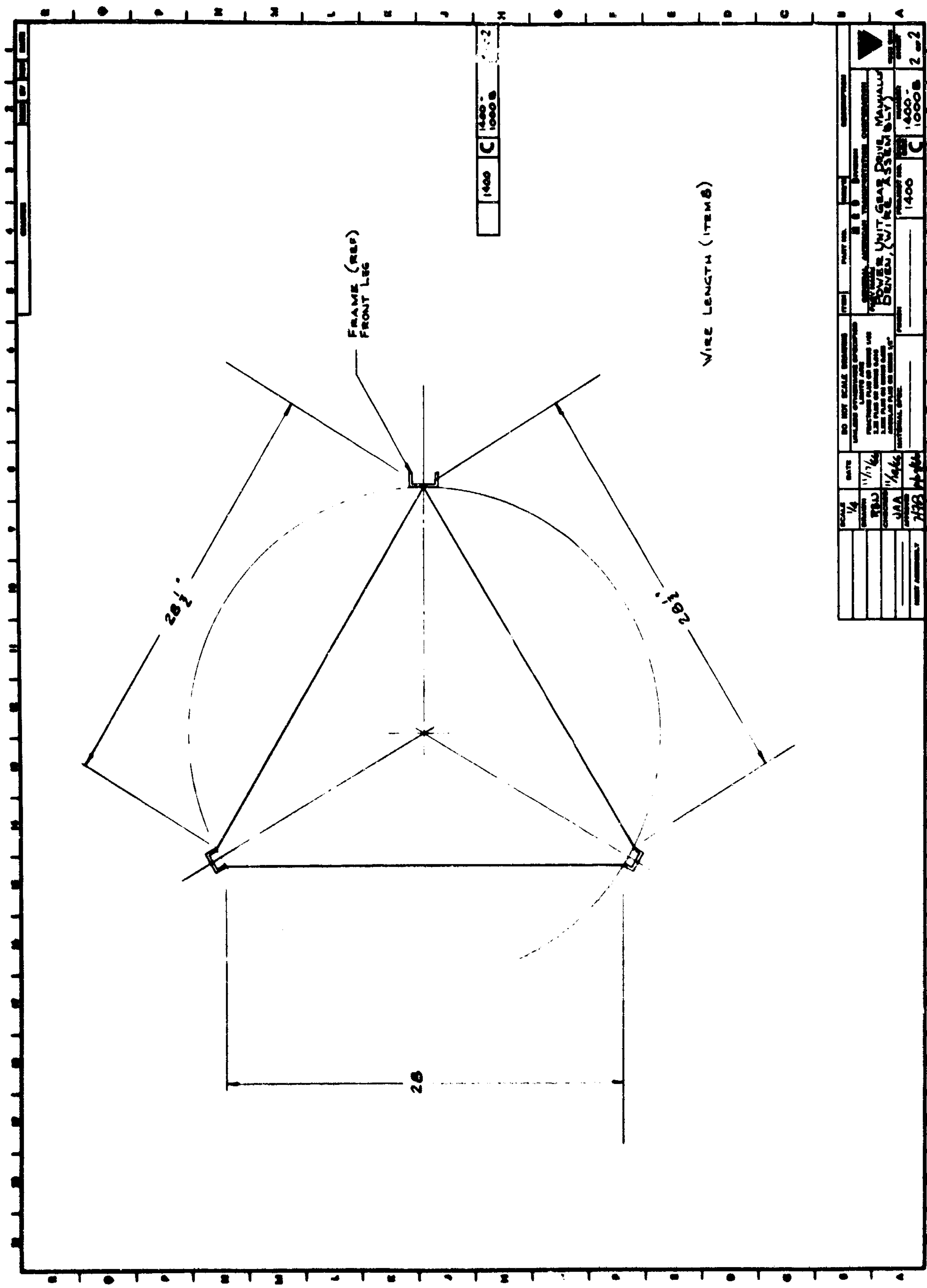

FIXTURE
STARTER
LAMP
STARTER
LAMP
100 FT CORD
20 FT CORD
GENERAL AMERICAN TRANSPORTATION CORPORATION
LAMP FIXTURE, FLUORESCENT
ELECTRICAL SCHEMATIC
1400-1100

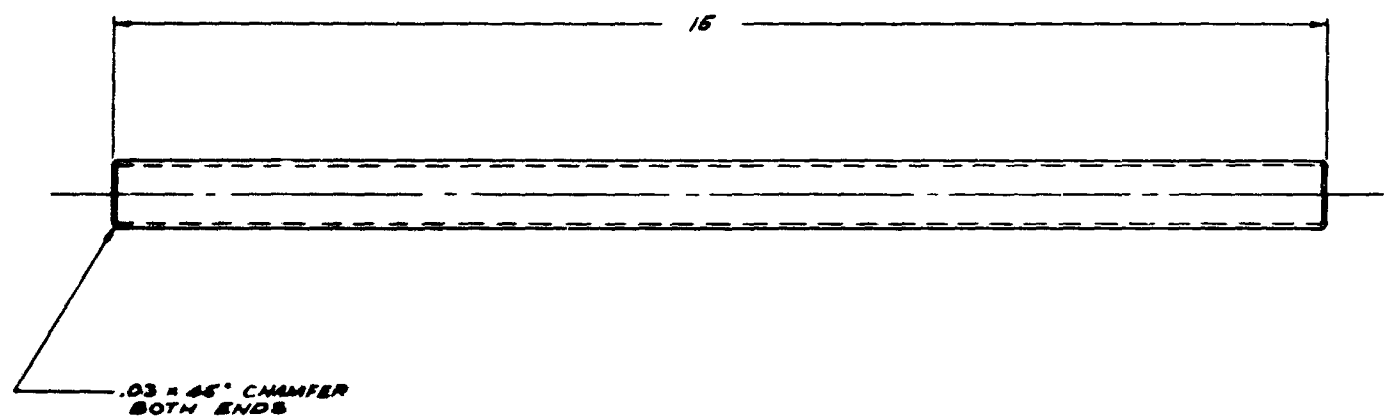
APPENDIX B

--DRAWINGS--

POWER UNIT WITH AN INTEGRAL GEARED TRANSMISSION




FRAME (REF)
FRONT LEG
WIRE LENGTH (ITEM 8)
28 1/2
28 1/2
28
1400
C
1400-1000B
POWER UNIT GEAR DRIVE, MANUALLY DRIVEN (WIRE ASSEMBLY)
1/4
RBW
JAA

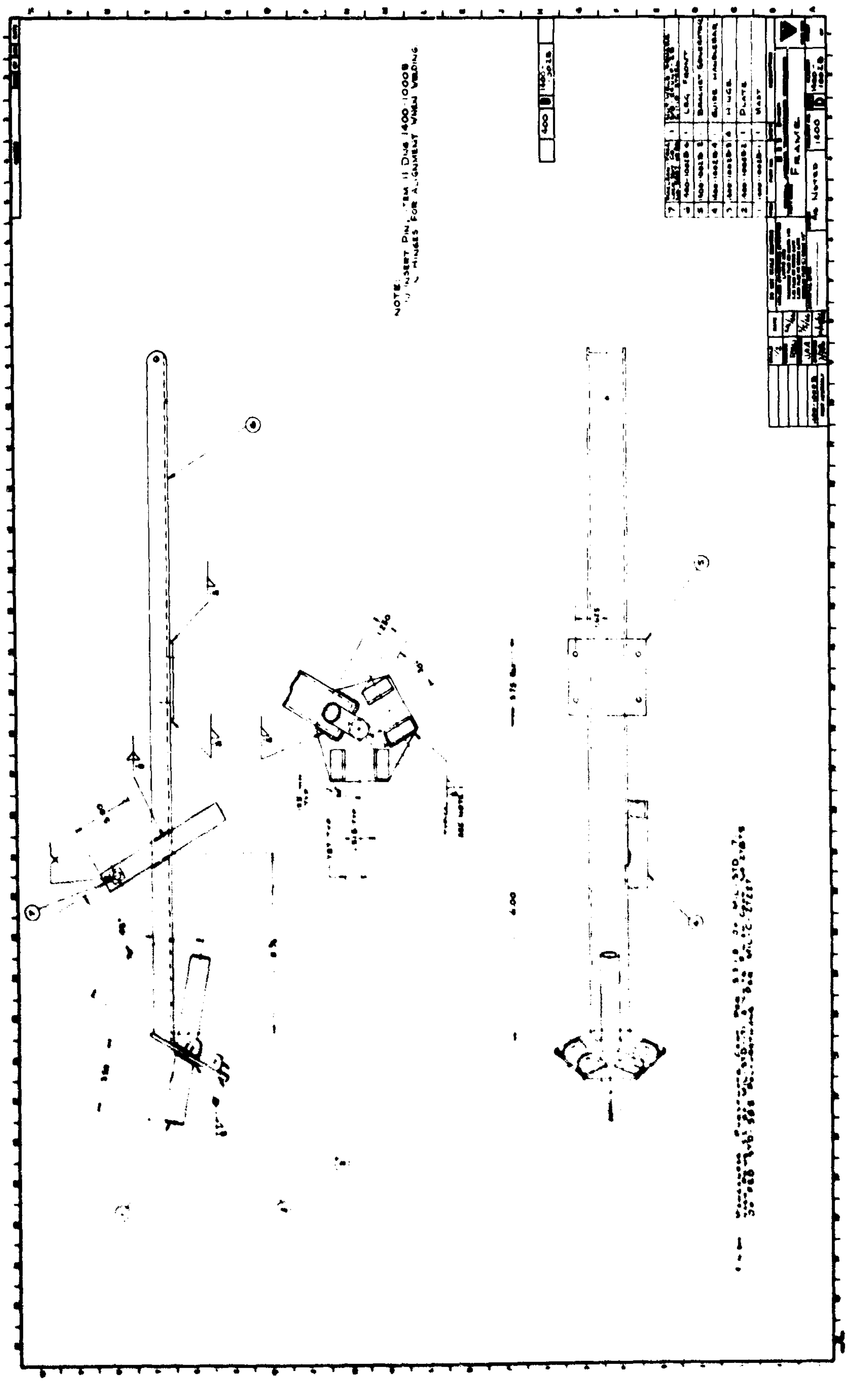


MATERIAL: .875 ±.004 O.D. x 16 BW GA (.065) WALL ELECTRIC WELDED COLD ROLLED STEEL TUBING. C1010.

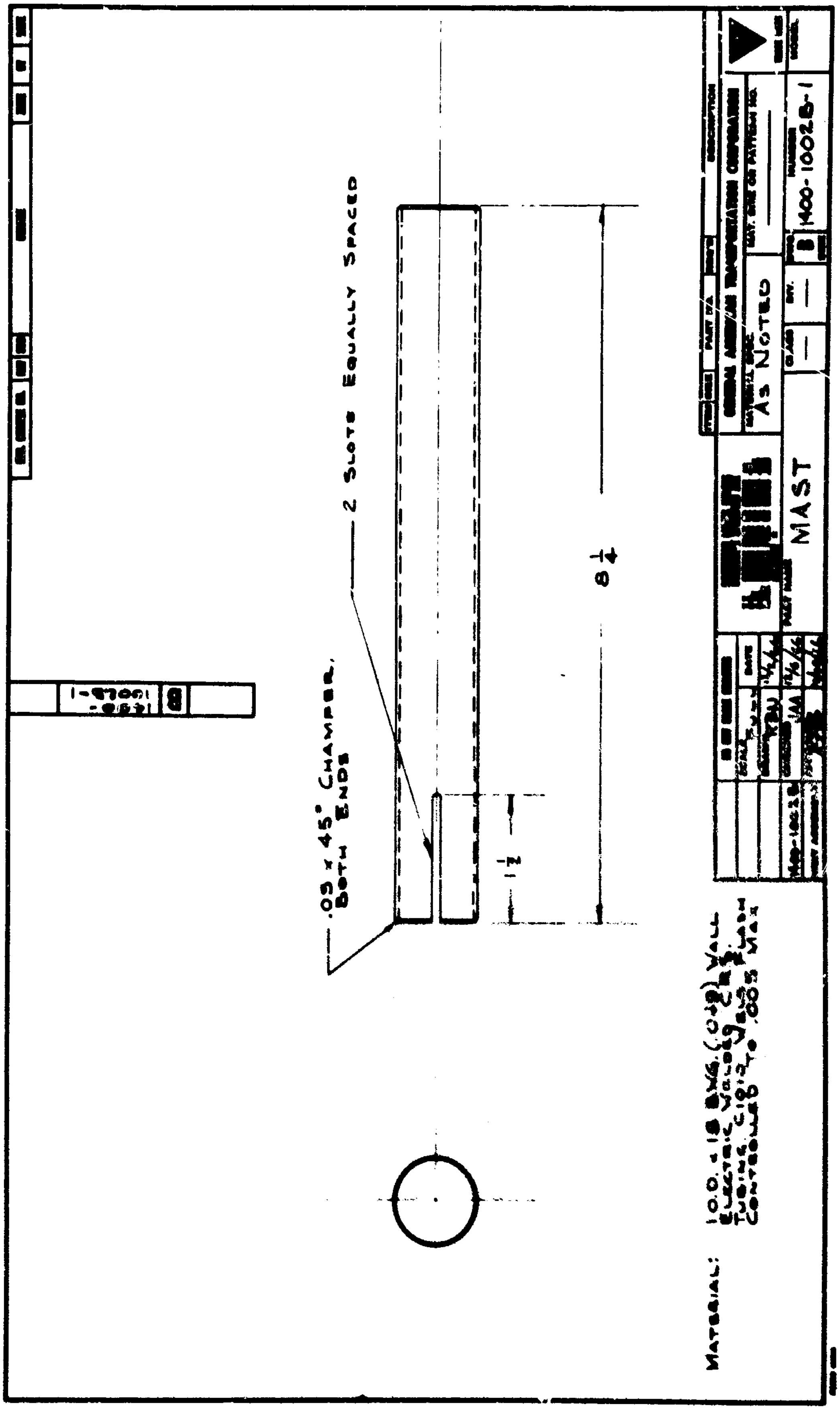
FINISH: MANGANESE PHOSPHATE COAT PER 6.3.1.3 OF MIL-STD-171, AND DRY FILM LUBRICANT PER MIL-L-8937.

POST, SADDLE

SCALE: FULL	FINISH: AS NOTED	AS NOTED
1400-10008	1400	C
1400 10018		



GENERAL AMERICAN RESEARCH DIVISION


2 SLOTS EQUALLY SPACED
.03 x 45° CHAMFER, BOTH ENDS
8 1/4
1 1/2
MATERIAL: 1 O.D. x 18 GA. (.049) WALL ELECTRIC WELDED C.R.S. TUBING, C1010, WELD FLASH CONTROLLED TO .005 MAX
AS NOTED
MAST
1400-10025-1

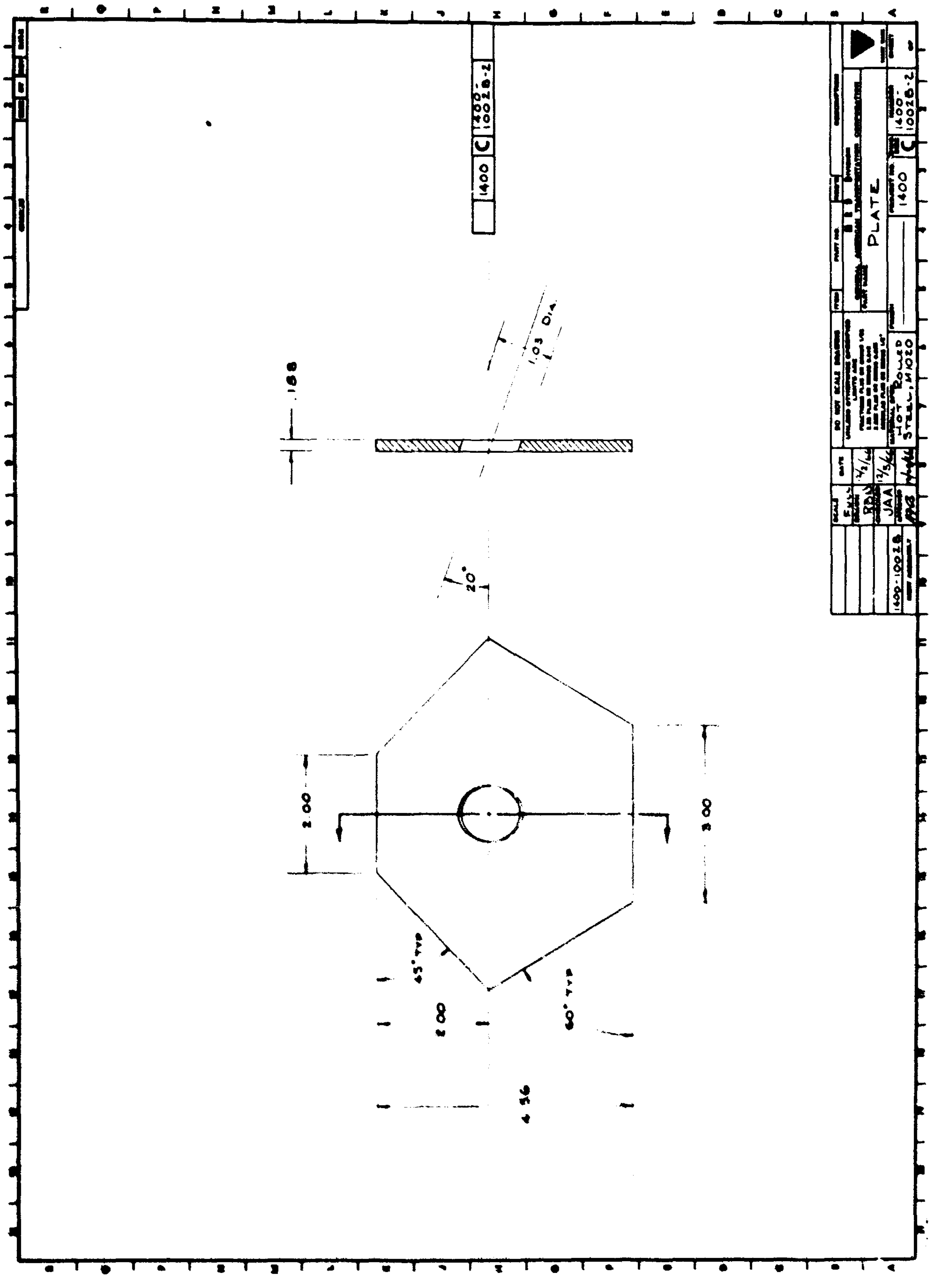
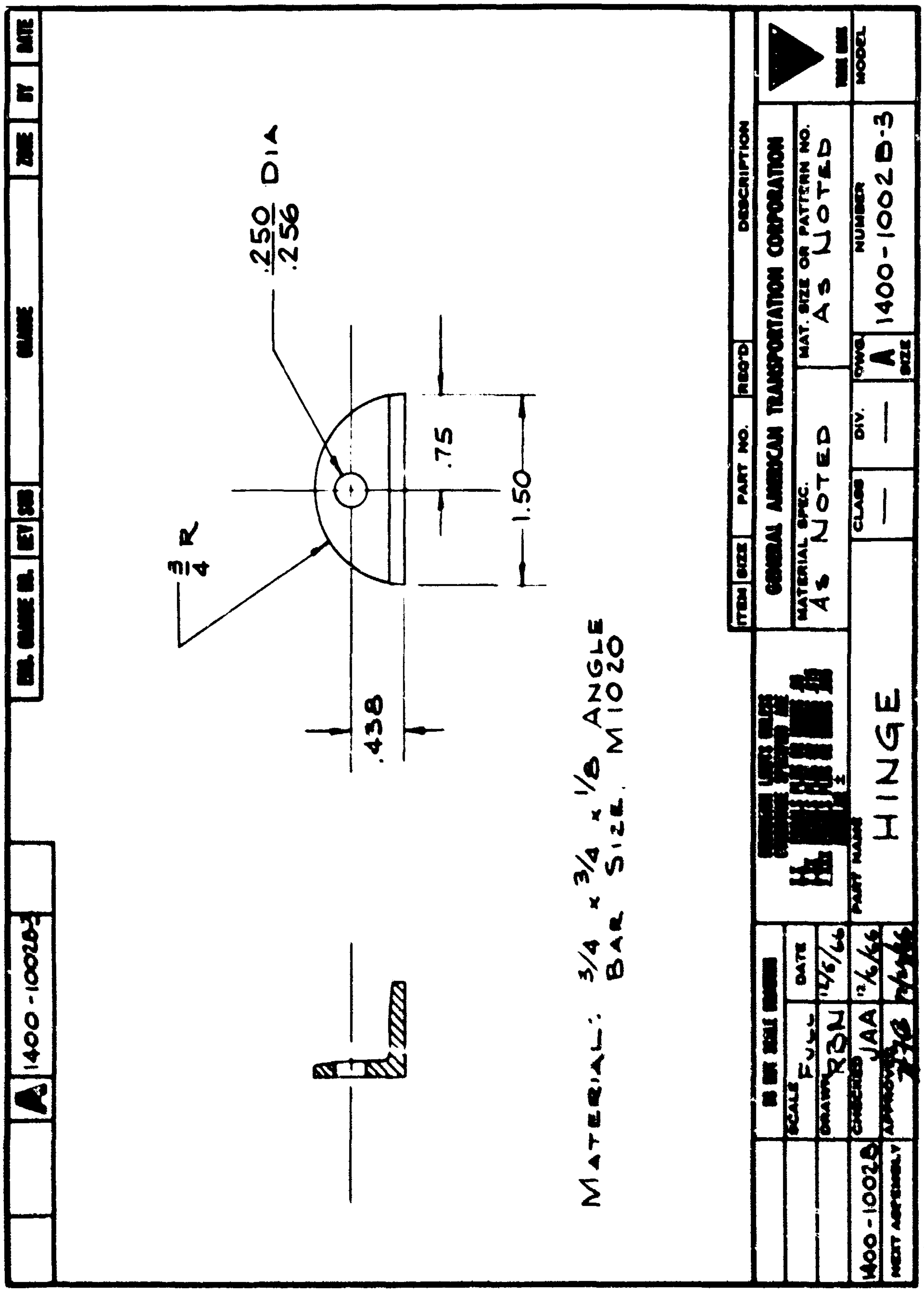
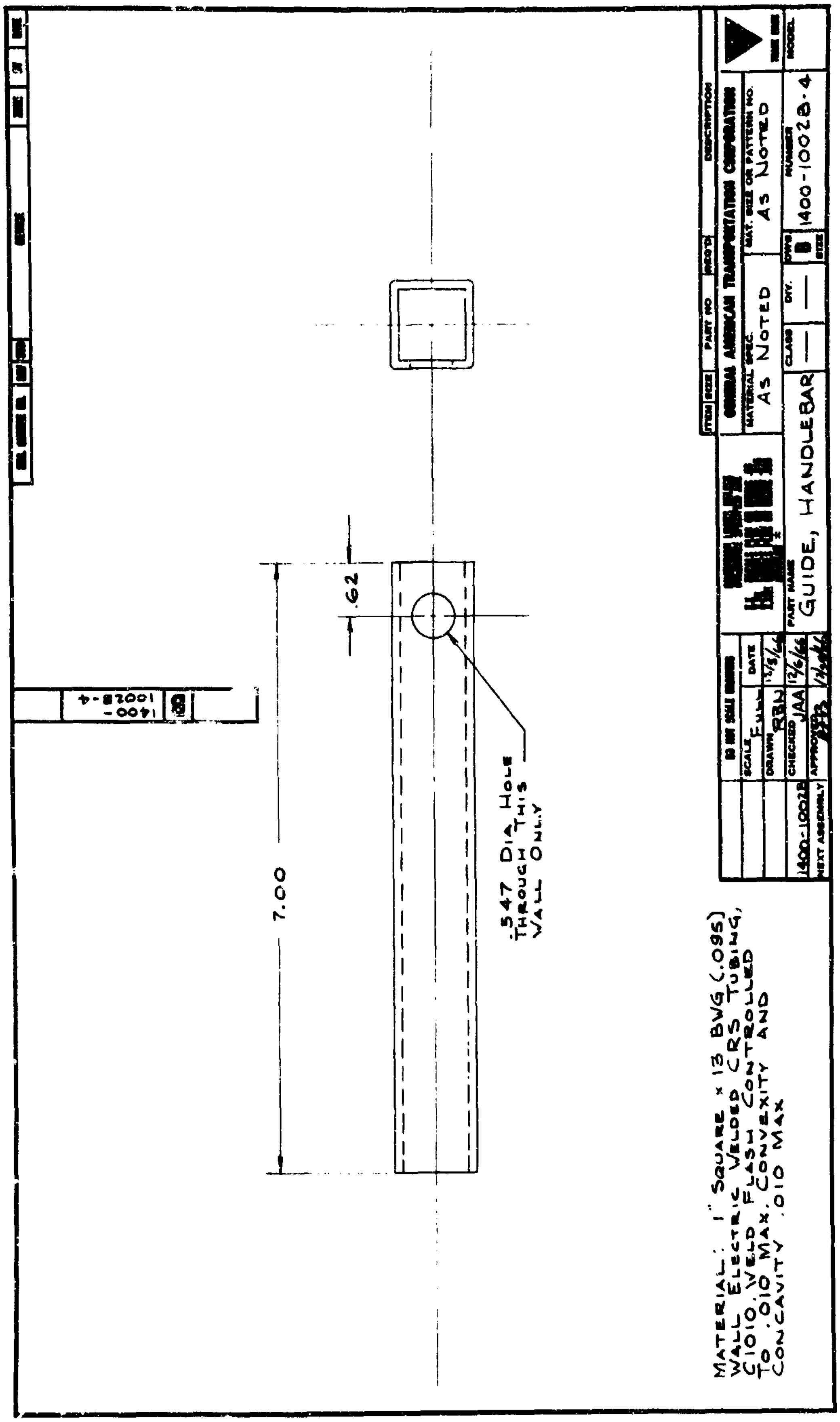


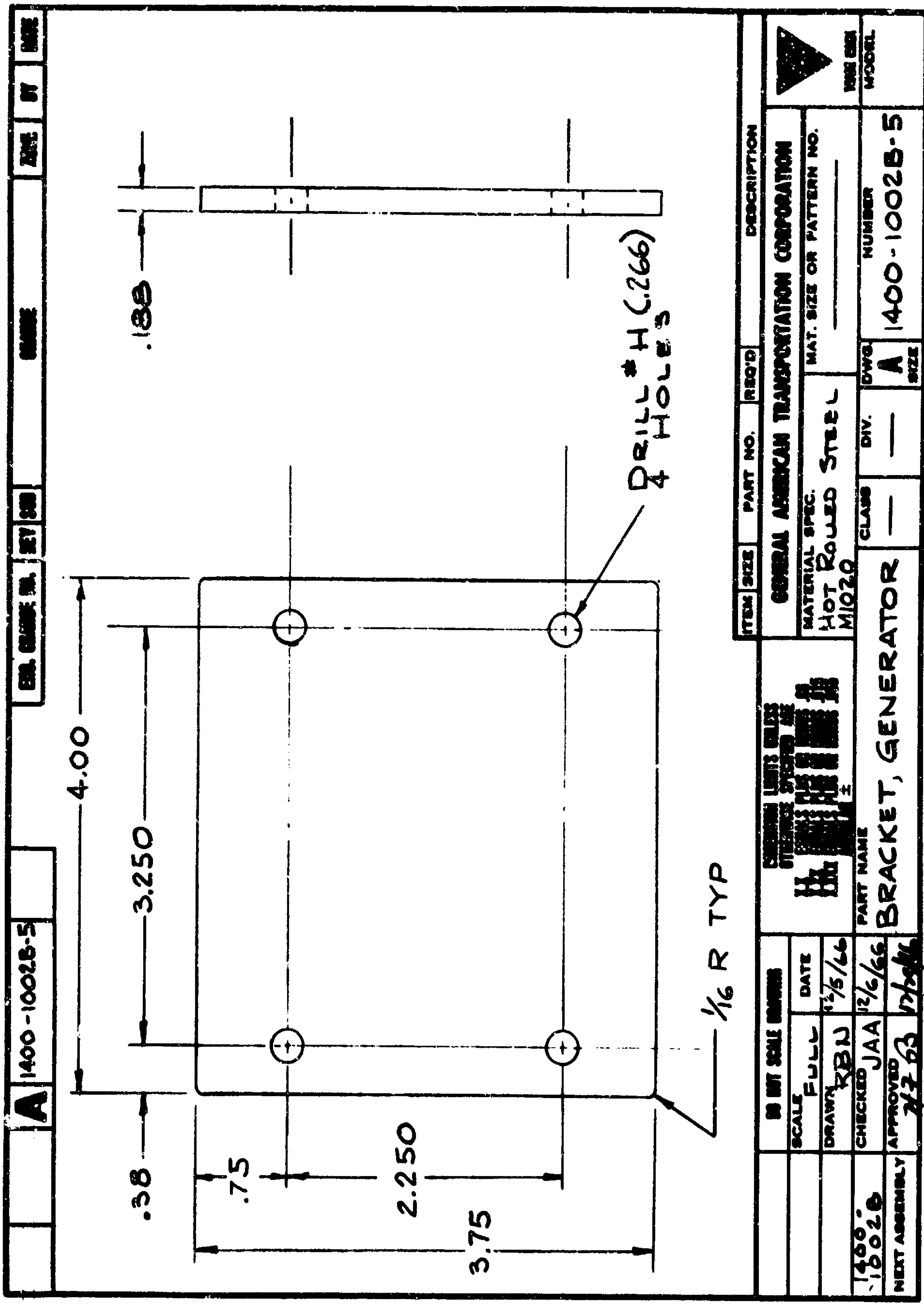
PLATE
1400
1400-10028-2
.188
1.03 DIA
20°
2.00
3.00
45° TYP
60° TYP
2.00
4.56
HOT ROLLED STEEL, M1020



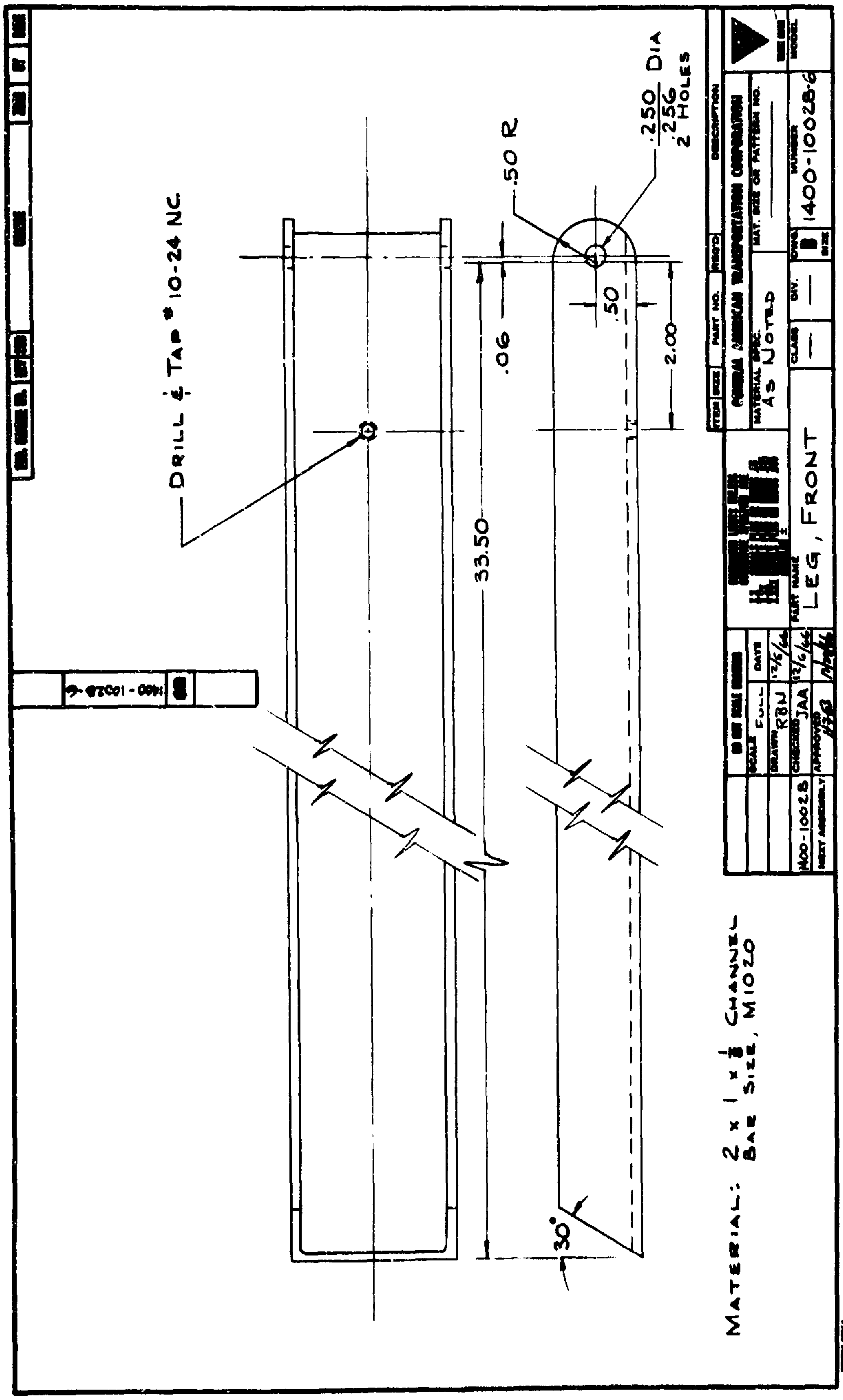
.250
.256 DIA
3/4 R
.75
1.50
.438
MATERIAL: 3/4 x 3/4 x 1/8 ANGLE
BAR SIZE M1020
A 1400-1002B-3
GENERAL AMERICAN TRANSPORTATION CORPORATION
ITEM SIZE PART NO. REQ'D DESCRIPTION
MATERIAL SPEC. As NOTED
MAT. SIZE OR PATTERN NO. As NOTED
CLASS —
DIV. —
DWG SIZE A
NUMBER 1400-1002B-3
MODEL
DO NOT SCALE DRAWING
SCALE FULL
DATE
DRAWN RBN 12/6/66
CHECKED JAA 12/6/66
APPROVED
PART NAME HINGE
NEXT ASSEMBLY 1400-1002B

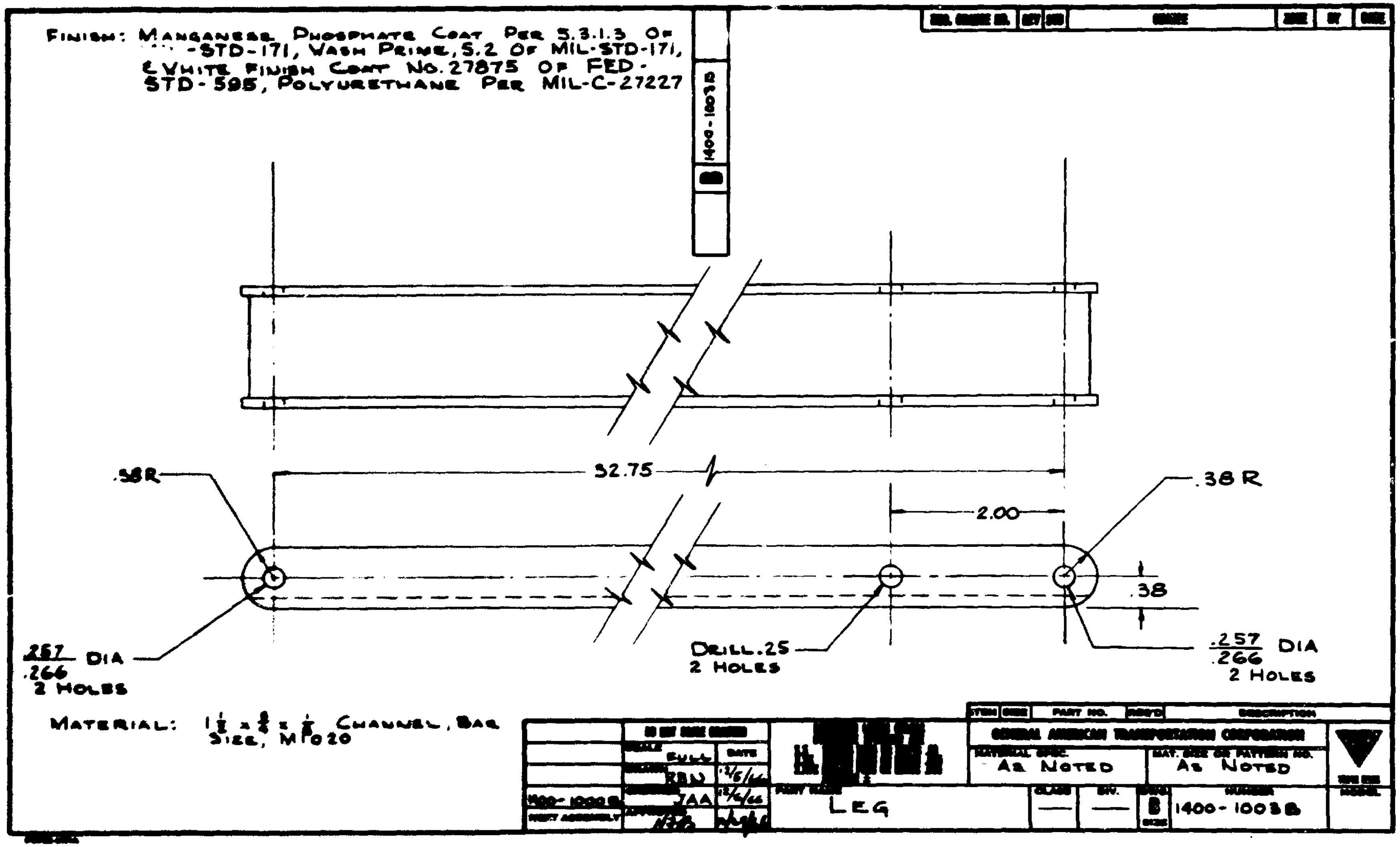


GENERAL AMERICAN RESEARCH DIVISION

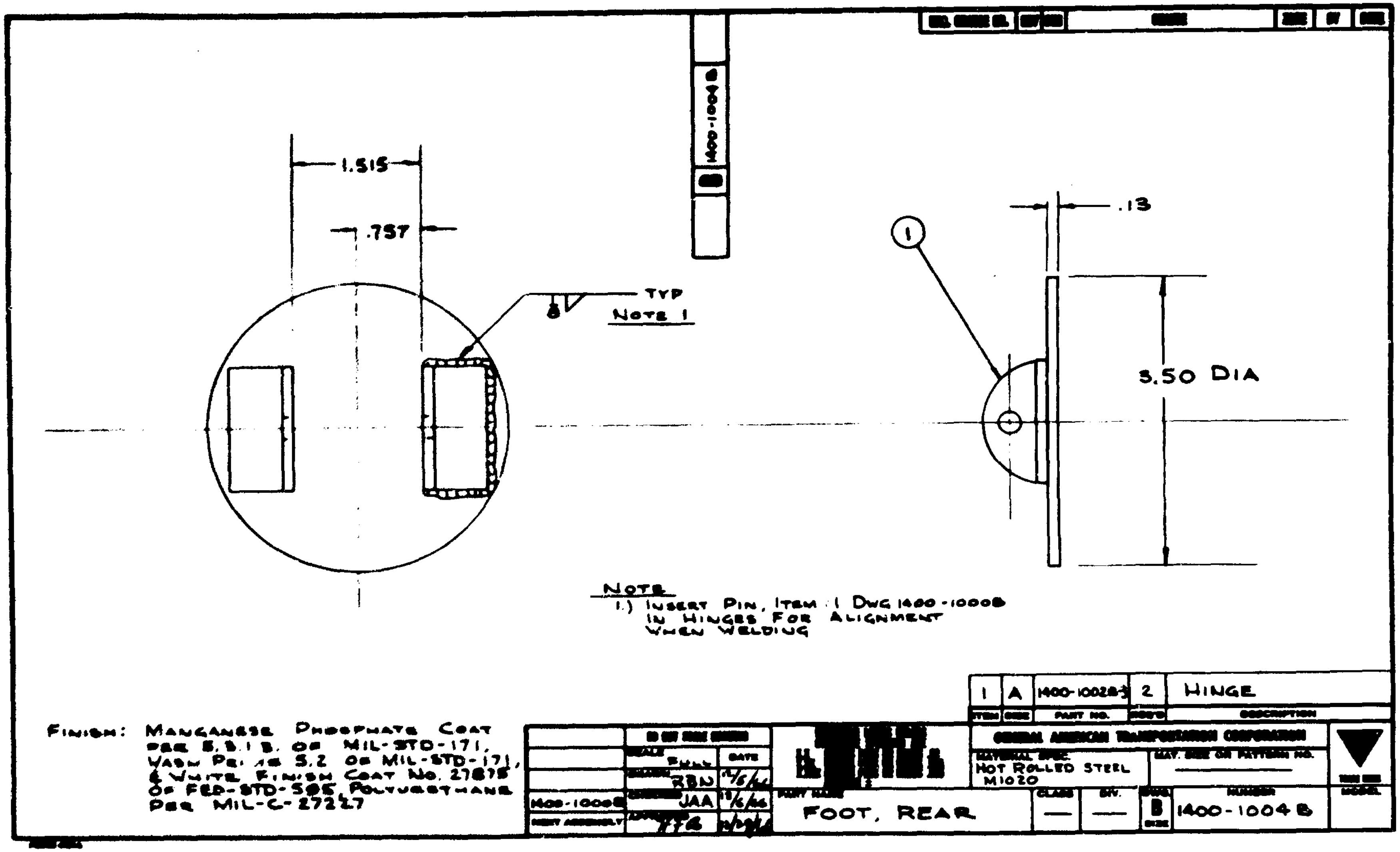


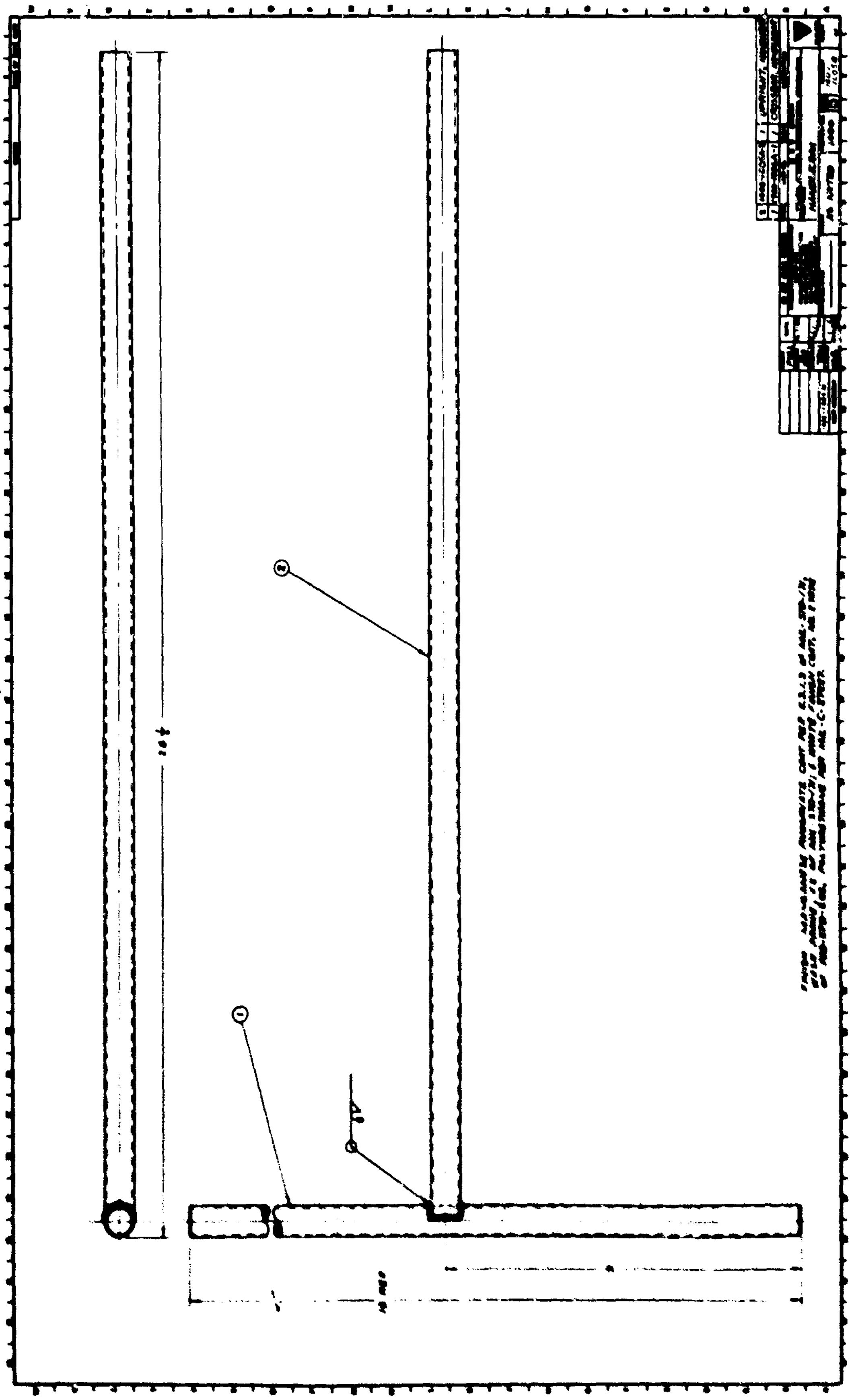
A
1400-1002B-5
.188
DRILL #H (.266)
4 HOLES
4.00
3.250
1/16 R TYP
.38
.75
2.250
3.75
ITEM
SIZE
PART NO.
REQ'D
DESCRIPTION
GENERAL AMERICAN TRANSPORTATION CORPORATION
MATERIAL SPEC.
HOT ROLLED STEEL
M1020
MAT. SIZE OR PATTERN NO.
DO NOT SCALE DRAWING
SCALE
FULL
DATE
DRAWN
RBN
12/5/66
CHECKED
JAA
12/6/66
APPROVED
NEXT ASSEMBLY
1400-1002B
PART NAME
BRACKET, GENERATOR
CLASS
DIV.
DWG SIZE
NUMBER
1400-1002B-5


DRILL & TAP #10-24 NC
.50 R
.250
.256 DIA
2 HOLES
.06
.50
2.00
33.50
30°
MATERIAL: 2 x 1 x 1/8 CHANNEL
BAR SIZE, M1020
GENERAL AMERICAN TRANSPORTATION CORPORATION
AS NOTED
1400-1002B-6
1400-1002B
SCALE FULL
DRAWN RBN
CHECKED JAA
LEG, FRONT

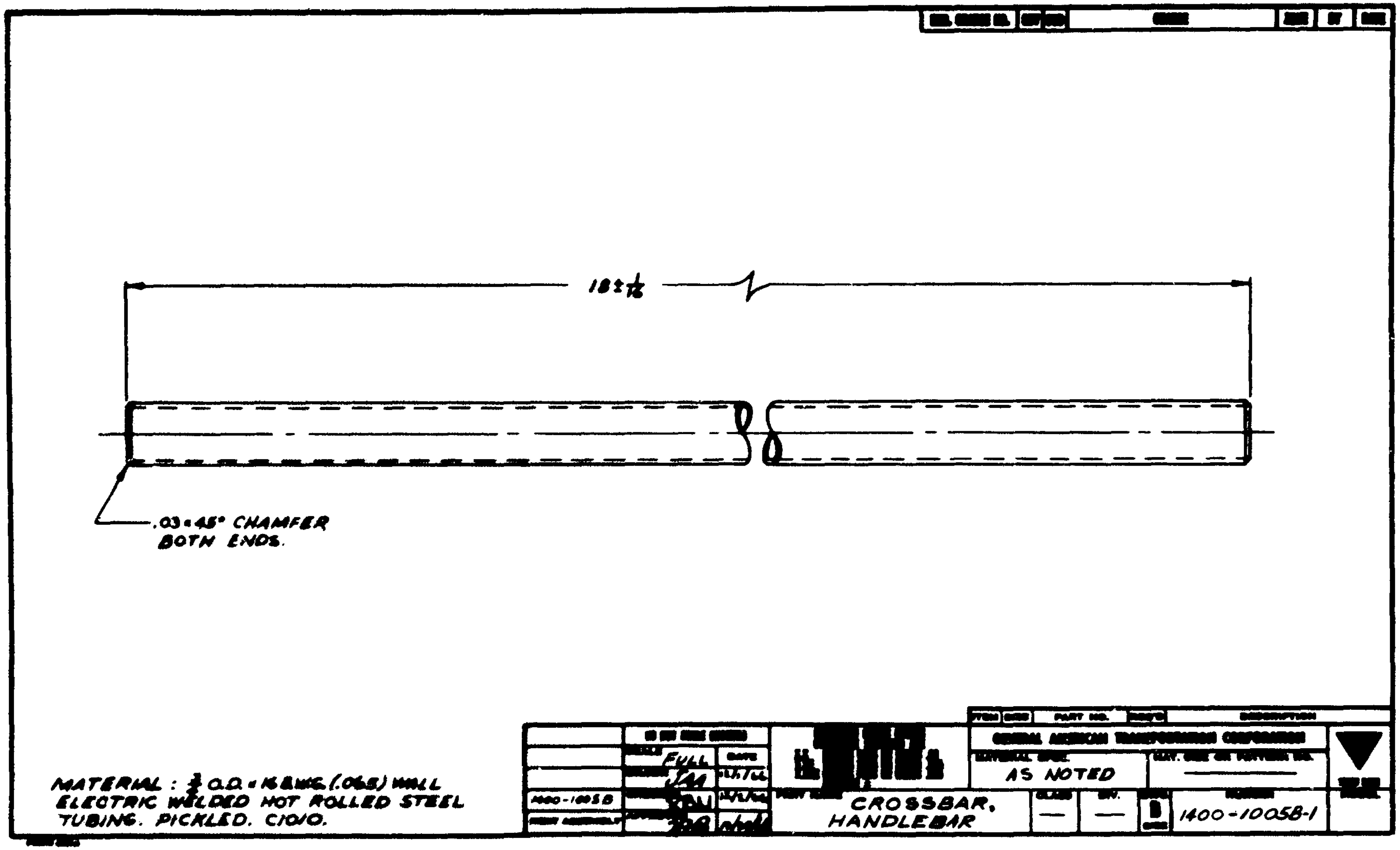


FINISH: MANGANESE PHOSPHATE COAT PER 5.3.1.3 OF -STD-171, WASH PRIME, 5.2 OF MIL-STD-171, & WHITE FINISH COAT NO. 27875 OF FED-STD-595, POLYURETHANE PER MIL-C-27227
1400-1003B
52.75
.38R
.38 R
2.00
.38
.257/.266 DIA 2 HOLES
DRILL .25 2 HOLES
.257/.266 DIA 2 HOLES
MATERIAL: 1 1/2 x 3/4 x 1/8 CHANNEL, BAR SIZE, M1020
GENERAL AMERICAN TRANSPORTATION CORPORATION
AS NOTED
AS NOTED
FULL
RBW
AA
1400-1000B
LEG
B
1400-1003B

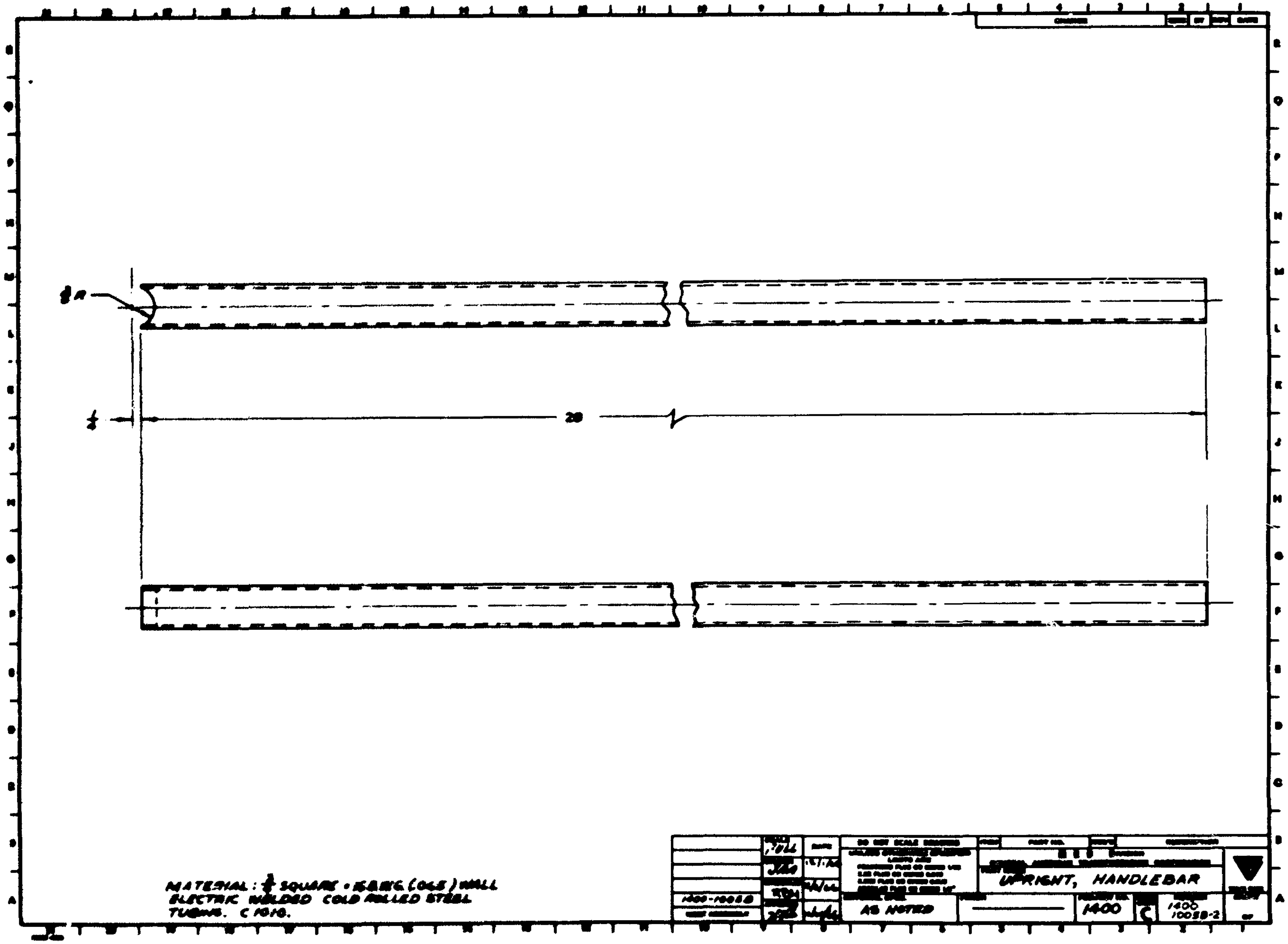

1.515
.757
TYP
NOTE 1
.13
1
3.50 DIA
NOTE
1.) INSERT PIN, ITEM 1 DWG 1400-1000B IN HINGES FOR ALIGNMENT WHEN WELDING
FINISH: MANGANESE PHOSPHATE COAT PER 5.3.1.3. OF MIL-STD-171, WASH PER 5.2 OF MIL-STD-171, & WHITE FINISH COAT No. 27875 OF FED-STD-595, POLYURETHANE PER MIL-C-27227
1 A 1400-1002B-3 2 HINGE
ITEM PART NO. DESCRIPTION
GENERAL AMERICAN TRANSPORTATION CORPORATION
MATERIAL SPEC. HOT ROLLED STEEL M1020
SCALE FULL
RBN 11/5/66
JAA 11/6/66
1400-1000B
NEXT ASSEMBLY
FOOT, REAR
B 1400-1004B
1400-1004B

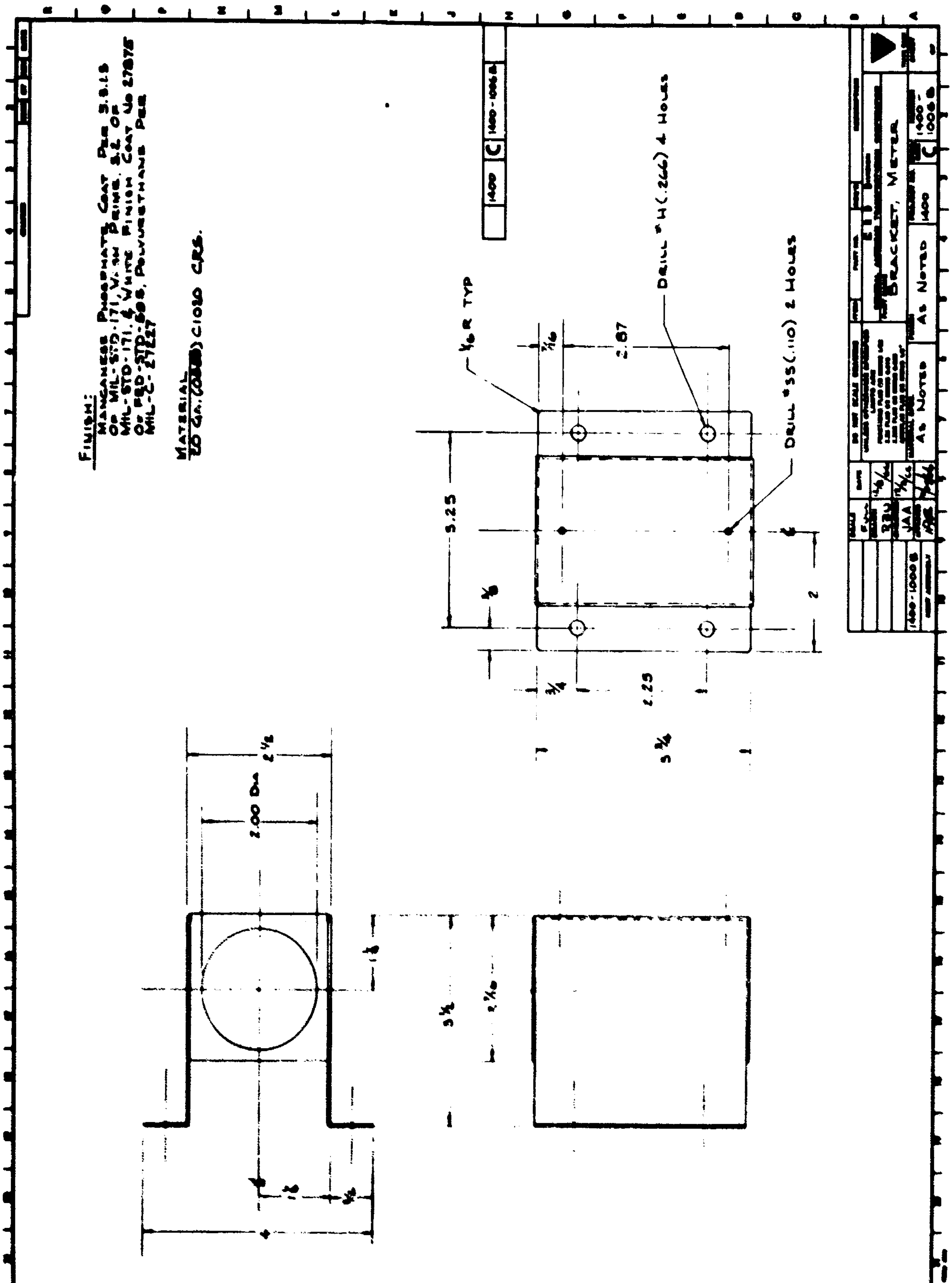


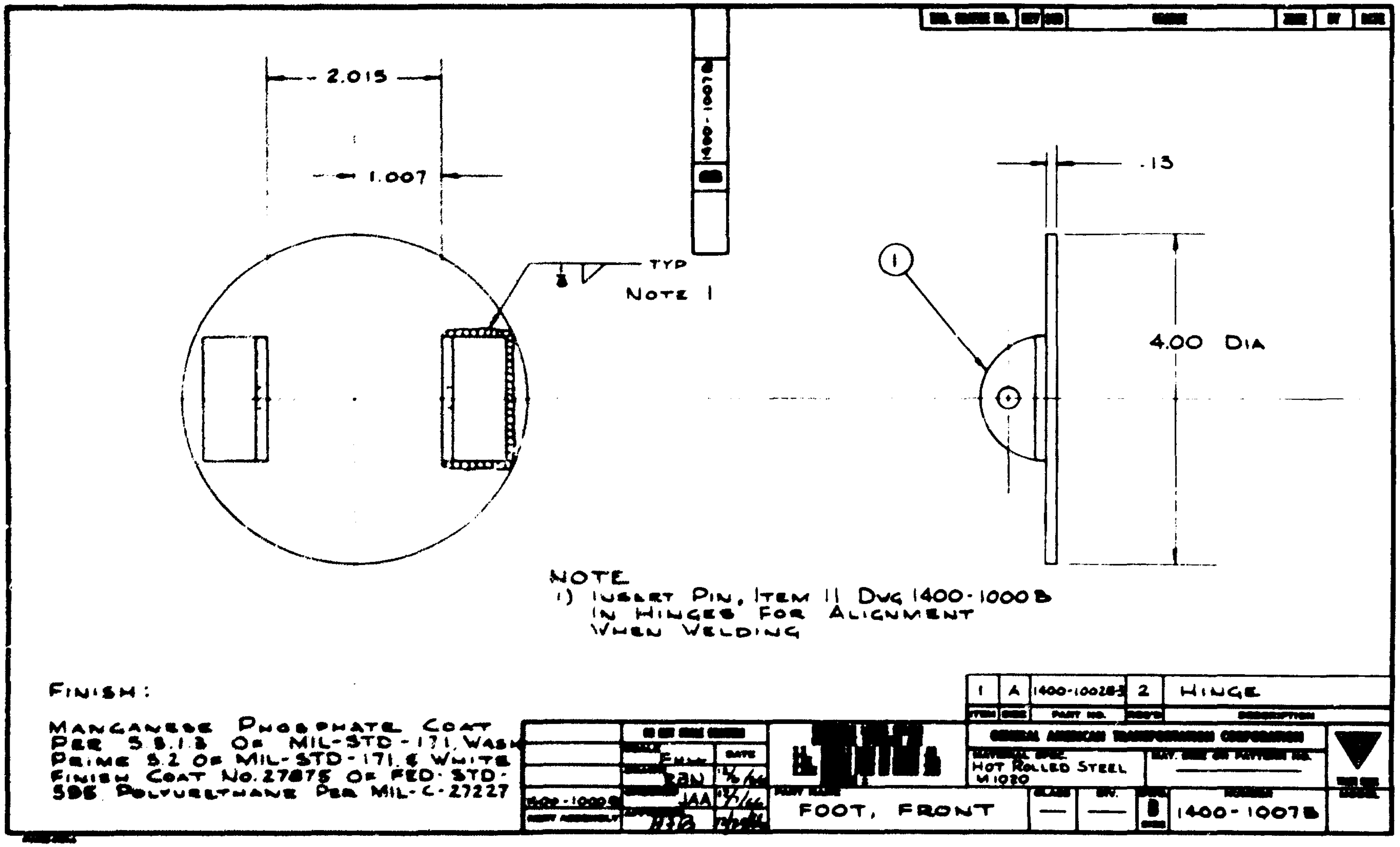
GENERAL AMERICAN RESEARCH DIVISION



GENERAL AMERICAN RESEARCH DIVISION


UPRIGHT, HANDLEBAR
1400
1400-10058-2
AS NOTED
20
MATERIAL: SQUARE • 16 GA. (.065) WALL ELECTRIC WELDED COLD ROLLED STEEL TUBING. C 1010.


FINISH:
MANGANESE PHOSPHATE COAT PER
MATERIAL
C1050 CRS.
DRILL #H (.266) 4 HOLES
DRILL #55 (.110) 2 HOLES
1/16 R TYP
2.87
5.25
2.25
2.00 DIA
BRACKET, METER
AS NOTED
1400
C
1400-1006B


2.015
1.007
.13
4.00 DIA
TYP
NOTE 1
1400-1007B
NOTE
1) INSERT PIN, ITEM 11 DWG 1400-1000B
IN HINGES FOR ALIGNMENT
WHEN WELDING
FINISH:
MANGANESE PHOSPHATE COAT
PER 5.3.1.3 OF MIL-STD-171, WASH
PRIME 5.2 OF MIL-STD-171 & WHITE
FINISH COAT No. 27875 OF FED-STD-
595 POLYURETHANE PER MIL-C-27227
1 A 1400-10028B 2 HINGE
GENERAL AMERICAN TRANSPORTATION CORPORATION
HOT ROLLED STEEL
M1020
1400-1000B
FOOT, FRONT
1400-1007B

UNCLASSIFIED

Security Classification

DOCUMENT CONTROL DATA - R&D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) General American Transportation Corporation 7449 N. Natchez Avenue Niles, Illinois 60648	2a. REPORT SECURITY CLASSIFICATION Unclassified 2b. GROUP

3. REPORT TITLE

SHELTER LIGHTING KIT (U)

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

Final Report

5. AUTHOR(S) (Last name, first name, initial)

Neveril, Robert B.
Behls, Herman F.

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
January, 1967	86	17

8a. CONTRACT OR GRANT NO. SRI Subcontract No. B-8700(4949A-62)-US b. PROJECT NO. OCD Work Unit 1427A c. d.	9a. ORIGINATOR'S REPORT NUMBER(S) GARD Report 1400 9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report) None

10. AVAILABILITY/LIMITATION NOTICES

Distribution of this document is unlimited.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY Office of Civil Defense Department of the Army, OSA Washington, D. C. 20310

13. ABSTRACT

The Shelter Lighting Kit includes a manually-driven power unit and a fluorescent lighting system. Two power unit designs are presented for preproduction fabrication and evaluation. One power unit has a generator mounted on a bicycle-type frame and driven by a chain and sprocket transmission; while the other unit has a generator with an integral geared transmission mounted on a folding tripod frame. Both power units are designed for one-man operation with a power input of 0.1 horsepower at a nominal pedal speed of 55 rpm and a nominal generator output of 50 watts at 120 volts AC. The selection of either design for the production model will depend on their performance and a cost analysis. The fluorescent lighting system consists of two adjustable lamp fixtures and two 20-watt or 25-watt preheat fluorescent lamps operated in series (selected lamp wattage will depend on the overall system efficiency). The estimated production cost of the lighting kit is $90. (U)

An incandescent lighting system is proposed as an optional accessory for night lighting or background illumination in multi-room shelters. This lighting system consists of five 10-watt incandescent lamps with adapter sockets and five 50-foot extension cords. The estimated cost of this accessory is $7.30. (U)

DD FORM 1 JAN 64 1473

UNCLASSIFIED

Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
CIVIL DEFENSE SYSTEMS FALLOUT SHELTERS DESIGN GENERATORS PORTABLE EXERCISE LIGHT LIGHTING EQUIPMENT BATTERIES & COMPONENTS RADIO COMMUNICATION SYSTEMS						

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